# OPERATING INSTRUCTIONS

for

# TYPE 1021-A

# STANDARD-SIGNAL GENERATOR

GENERAL RADIO COMPANY

CAMBRIDGE 39 MASSACHUSETTS

NEW YORK CHICAGO LOS ANGELES

U. S. A.

Supplement to

OPERATING INSTRUCTIONS FOR TYPE 1021-A

(Form 728-C, June, 1953)

To allow I-F testing of Television Receivers, a 40-50 Mc range has been added to the 50-250 Mc range of the Type 1021-AV Standard Signal Generator and the Type 1021-P3 V-H-F Generator Unit which is now known as the Type 1021-P3B.

Specifications and Operating Instructions apply unchanged to the additional frequency range. The hold-down clamp mentioned in Paragraph 4.32(a) is no longer needed and can be omitted.

On page 4, first column, last line, change R-102 to R-103.

The wiring diagram (Figure 7) of the Type 1021-P1 Power Supply shows an anchor terminal (A.T. No. 4) and a rheostat (R-19) which have been added to allow the use of a new carrier-frequency section, the Type 1021-P4 U-H-F Unit. This new section extends the frequency range to 2000 Mc. The rheostat is adjusted so that its resistance and the resistance of the meter total 1000 ohms.

Experience indicates that the statements made under Section 2.4 OUTPUT SYSTEM are sometimes forgotten when output settings are made under Sections 3.5 and 3.7. It should be remembered that the voltmeter indicates the voltage across the load and the 50-ohm internal terminating impedance.

Paragraph 4.4, page 7, should be changed by deleting the last sentence and adding the following: Any 1N21-B crystal can be used as replacement and will give accurate results if used in accordance with Paragraphs 3.4, 3.6, and 3.7 for output voltages below 0.5 volt. To obtain accurate output voltages between 0.5 and 2 volts in accordance with Paragraph 3.5, the crystal characteristic has to match the meter scale. Selected crystals that conform to the original accuracy specifications of the Signal Generator can be obtained from the General Radio Company. If desired, any 1N21-B crystal can be checked between 0.5 and 2 volts by the following procedure:

Disconnect the long shield lead from the oscillator circuit by unplugging the shield connector at the rear of the output voltage-rectifier unit. At this same point now feed into the voltage-rectifier unit an external 60-cycle calibrating voltage in parallel with an accurate vacuum-tube voltmeter such as the General Radio Type 1800-A. For this calibration, the power supply must be turned off and the PUSH TO CAL button depressed.

Paragraph 4.5, page 7, should be changed by substituting the following for the second sentence of the last paragraph: This can be checked with the PUSH TO CAL button depressed by measuring the 60-cycle voltage between the exposed terminal of the Type 874-VR in back of the panel just below the PUSH TO CAL switch and ground, with a reliable vacuum-tube voltmeter such as the General Radio Type 1800-A.

G E N E R A L  R A D I O  C O M P A N Y

Cambridge, Massachusetts

June, 1955 Printed in U.S.A.

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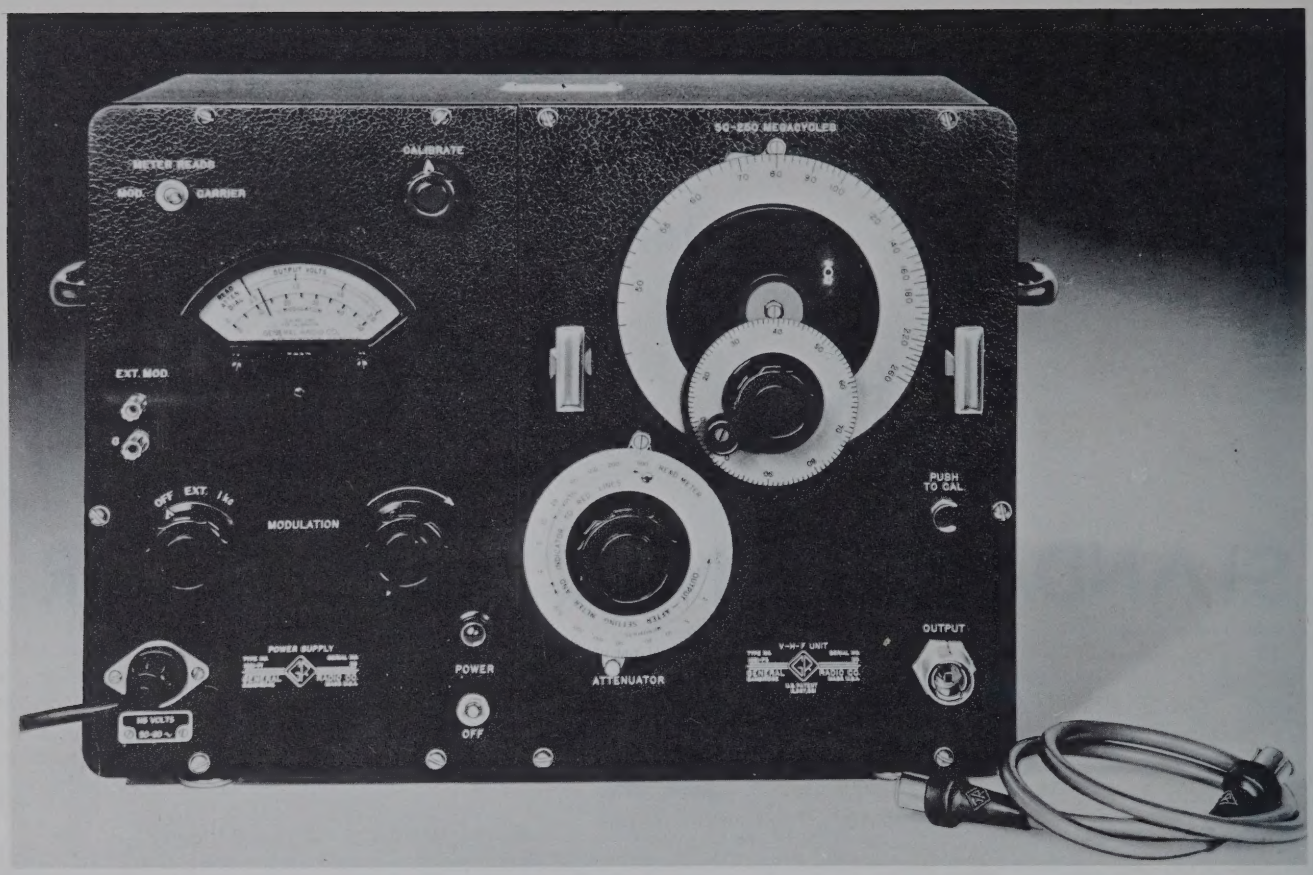


## SPECIFICATIONS

### Type 1021-AU U-H-F Standard-Signal Generator

**Carrier Frequency Range:** 250 Mc to 920 Mc in one band.

**Frequency Calibration:** Direct reading to ±1%.

**Output Voltage:** Continuously adjustable from 0.5 μv to 1.0 volt, open-circuit.

**Output Impedance:** 50 ohms ±10%.

**Output Voltage Accuracy:** Over-all accuracy of output voltage is better than ±20%. The accuracy of output voltmeter calibration between 0.5 volt and 1.0 volt is better than ±10%. The accuracy of the attenuator dial calibration for voltages between 1.0 μv and 0.1 volt is better than ±5%; from 0.1 volt to 0.5 volt, better than ±10%. At 920 Mc, the resonance error in the voltmeter is +6%.

**Amplitude Modulation:** Adjustable, 0 to 50%. Internal, 1000 c ±5%. External, flat within 3 db from 30 c to 15 kc. For 50% modulation, external audio oscillator must supply 18 volts across a 100 kilohm load.

**Envelope Distortion:** Less than 5% at 50% modulation.

**Noise Level:** Carrier noise level corresponds to about 0.2% modulation.

**Incidental Frequency Modulation:** For 50% amplitude modulation the incidental fm is approximately 100 parts per million for frequencies up to 400 Mc and is approximately 1000 parts per million at 920 Mc. When lower values of incidental fm are required, the Type 1000-P6 Crystal Modulator is recommended.

**Leakage:** Stray fields and residual output voltage cannot be detected with a receiver having 2 to 3 μv sensitivity.

**Terminals:** Type 874 Coaxial Terminals are provided for the output connection.

**Power Supply:** 115 or 230 volts, 50 to 60 cycles. Power input is approximately 50 watts.

**Tubes:** Supplied with the instrument:

1 Sylvania RT-434 Oscillator
1—6X5-GT
1—6K6-GT
1—Amperite 6-4
2—0C3

**Accessories Supplied:**

1 Type 874-R20 3-foot Coaxial Cable (50 Ω)
1 Type 874-C Coaxial Cable Connector
1 Type CAP-35 Power Cord

**Other Accessories Available:** Not supplied, but available on order are Type 874-GF 20 db Attenuator Pad, Type 874-GG 10 db Attenuator Pad, Type 874-K Coupling Capacitor, and Type 1000-P6 Crystal Modulator.

**Mounting:** The aluminum cabinet has a black wrinkle finish. The left-hand side houses the Type 1021-P1 Power Supply; the right-hand side houses the Type 1021-P2 U-H-F Unit. Panels are black crackle-finished aluminum.

**Dimensions:** (Height) 14⅜ x (width) 20¼ x (depth) 10 9/16 inches, over-all.

**Net Weight:** 37½ pounds.

### Type 1021-AV V-H-F Standard-Signal Generator

Same as Type 1021-AU (above) except as noted.

**Carrier Frequency Range:** 50 Mc to 250 Mc in one band.

**Incidental Frequency Modulation:** For 50% amplitude modulation the incidental fm is approximately 100 parts per million for frequencies up to 100 Mc, and is approximately 500 parts per million at 250 Mc. When lower values of incidental fm are required, the Type 1000-P6 Crystal Modulator or the Type 1023-A Amplitude Modulator is recommended.

**Tubes:** Supplied with the instrument:

1 GE 12AT7 Oscillator
Other tubes as listed above.

**Mounting:** Cabinet is same as for Type 1021-AU, above. Generator consists of the Type 1021-P1 Power Supply and Type 1021-P3 V-H-F Unit.

U. S. Patent Nos. 2,125,816, 2,548,457, 2,367,681.

# OPERATING INSTRUCTIONS

## for

# Type 1021-A Standard-Signal Generator

## SECTION 1.0 GENERAL

### 1.1 THE TWO UNITS OF THE TYPE 1021-A

The Type 1021-A Standard-Signal Generator has a carrier frequency range of 50 - 920 Mc. Since this wide range cannot be covered in a single band and since range switching is not practical at these high frequencies the Type 1021-A Standard-Signal Generator is made in two units, the Type 1021-AV for 50 - 250 Mc and the Type 1021-AU for 250 - 920 Mc.

These two signal generators consist each of a cabinet containing the Type 1021-P1 Power Supply at the left and one of the two interchangeable r-f sections, the Type 1021-P3 for 50 - 250 Mc or the Type 1021-P2 for 250 - 920 Mc, on the right.

Functionally and in arrangement of the front panel, the two r-f sections are much alike and the following discussion applies to both unless a distinction is specifically mentioned.

If only one cabinet and power supply is available with the two r-f sections, a change can be made readily by replacing one section by the other. The only connection between power supply and r-f section is made by a multiconductor cable and plug attached permanently to the power supply.

### 1.2 PRINCIPLE OF OPERATION

The block diagram of Figure 1 shows the functional arrangement of the standard-signal generator. The upper part of the diagram represents either one of the two r-f sections and the lower part the power supply.

The operating frequency is set by the main six-inch dial of the carrier oscillator.

The output voltage is controlled by the ATTENUATOR. High output voltages are read directly on the CARRIER meter in the power supply which is energized

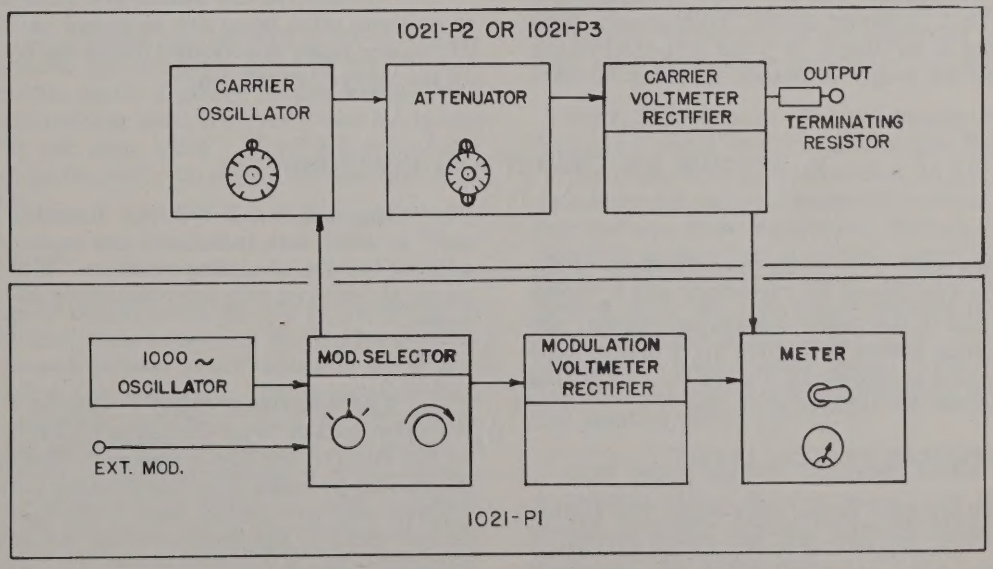


Figure 1. Functional block diagram of the Type 1021-A.

by the carrier voltmeter-rectifier contained in the r-f section. Low output voltages are set by the ATTENUATOR after establishing a reference level at 0.5 volt by means of the CARRIER meter.

The output impedance is determined by the cylindrical 50-ohm resistor between carrier voltmeter-rectifier and the output terminal on the front panel.

Amplitude modulation is produced in the plate supply of the carrier oscillator by an internal 1000-cycle oscillator or modulation amplifier depending on the position of the MODULATION switch. The depth of modulation is indicated by the panel voltmeter when the METER READS switch is set to MOD.

## 1.3 OPERATING CONTROLS AND CHARACTERISTICS

Figure 2 is a panel view of the Type 1021-AV Standard-Signal Generator, showing the location of the controls and fittings which are indicated schematically in Figure 1.

1.31 Frequency Dial: The 50 - 250 Mc and the 250 - 920 Mc ranges of the two signal generators are each covered in a single band at the fundamental frequency of the vacuum-tube oscillator. The frequency can be set within ±1% on a six-inch diameter direct-reading dial. The drive knob carries a 100-division dial and makes about 11 turns to cover the range.

1.32 Attenuator Dial: The ATTENUATOR dial drives the mutual-inductance-type attenuator through a rack and pinion. The dial is calibrated from 0.5 microvolt to 0.5 volt and is set to an adjustable index. The index is moved by a small knob directly beneath the attenuator dial and is set when the reference level is established.

1.33 Output Terminal: The OUTPUT terminal is a Type 874 Coaxial Connector on the front panel. The output impedance is 50 ohms. A Type 874-R20 Patch Cord with three-foot length of double shielded 50-ohm polyethylene cable and a Type 874-C Cable Connector are furnished.

1.34 Panel Meter and Meter Switch: The panel meter is located in the power supply unit and is controlled by a METER READS switch located just above and to the left of the meter. With the switch in CARRIER position, the panel meter indicates the voltage across a crystal rectifier located just ahead of the output terminating resistor. Voltages of 0.5 volt and over are read directly.

With the switch in MODulation position, the meter indicates the audio-frequency voltage appearing at the carrier oscillator plate in terms of percentage modulation. Full scale corresponds to approximately 50 volts and to 50% modulation.

1.35 Calibration Switch and Calibration Control: The calibration switch marked PUSH TO CAL. at the right-hand side of the carrier oscillator panel is a push-button switch which applies 0.5 volt 60 cycles, derived from the regulated heater supply, across the carrier voltmeter-rectifier and simultaneously turns off the plate supply of the carrier oscillator. The CALIBRATE control knob located to the right and above the panel meter adjusts the meter sensitivity so that it will read 0.5 volt when the PUSH TO CAL. button is depressed.

1.36 Modulation Controls and Terminals: Two knobs on the power supply panel are labelled MODULATION. The left-hand knob controls a switch which turns the modulation off, or selects external modulation, or internal modulation at 1000 cycles. The right-hand knob controls the amplitude of the modulating voltage appearing at the carrier oscillator plate.

When the MODULATION switch is at EXT., connections from the external modulating source are made at the terminals marked EXT. MOD. located at the left of the panel meter.

1.37 Power On-Off Switch and Pilot Lamps: Power switch and pilot lamp are mounted on the front panel. The power fuses are located inside the power supply unit on the power transformer.

# SECTION 2.0 CIRCUIT AND CONSTRUCTION

## 2.1 CIRCUIT

The circuit diagrams of the r-f portions of the signal generator are shown in Figures 3 and 5, while the circuit diagram of the power supply, modulator, and metering portion is shown in Figure 7. Vacuum-tube layout of power unit is shown in Figure 9. Simplified diagrams are shown in Figures 4, 6, and 8.

## 2.2 RADIO-FREQUENCY OSCILLATOR

2.21 250 - 920 Mc Unit (Type 1021-P2): The radio-frequency oscillator for 250 - 920 Mc whose circuit is shown in Figures 5 and 6 is housed within two concentric shield cans on a cylindrically shaped aluminum casting. The tuning unit is a 2-1/2 inch diameter "butterfly circuit" in which both inductance and capacitance are varied without the use of sliding contacts. The wide frequency range is covered with approximately 80° rotation of the rotor.

The oscillator tube, V-200, is a Sylvania Type RT-434 Rocket-type Co-planar Triode. Connections to its electrodes are made with flexible clamps designed to provide low-impedance paths to the tuned circuit and to conduct heat from the tube terminals to the mass of the tuned circuit for cooling. The oscillator uses a Colpitts circuit in which oscillation conditions are determined mainly by the tube grid-to-

cathode and plate-to-cathode capacitances. Additional plate-to-cathode capacitance is added by means of two small soft-copper tabs, C 207-A and C 207-B, Figure 5, held close to the plate and connected to the cathode by means of a horse-shoe-shaped supporting member.

All the tube elements are fed through chokes. Amplitude modulation up to 50% is obtained by plate voltage modulation. Both heater and plate supplies are regulated. For 50% amplitude modulation the incidental fm is less than 0.01% up to 400 Mc and less than 0.10% up to 920 Mc.

A simple but rugged and smooth 50-to-1 worm-gear drive connects the butterfly rotor to the vernier frequency control, while a pinion on the worm shaft drives the direct-reading main frequency dial by means of its internally cut spur gear. Eleven turns of the vernier dial rotate the rotor through 81° and the main dial through 270°.

2.22 50 - 250 Mc Unit (Type 1021-P3): The circuit for the 50 - 250 Mc radio-frequency oscillator is shown in Figures 3 and 4. For this lower frequency range, a 4-1/2-inch diameter "semi-butterfly" tuning unit was chosen since it can be made smaller than a true butterfly circuit. A standard miniature-type twin-triode, the Type 12AT7, is used as the oscillator tube (V-100). The two triodes are connected in push-pull across the high impedance points of the tuned circuit. The rotor turns through 180° to change the frequency from just below 50 Mc to approximately 280 Mc. Uniform output is obtained up to 250 Mc.

The oscillator is mounted on the top of the cylindrically-shaped aluminum casting and is enclosed by two concentric shield cans. All leads to the oscillator circuit are well filtered. Amplitude modulation up to 50% is obtained by plate modulation. Both heater and plate supplies are regulated. For 50% amplitude modulation the incidental fm is less than 0.01% up to 100 Mc and approximately 0.05% at 250 Mc.

A simple but rugged and smooth 22-to-1 worm-gear drive connects the butterfly rotor to the vernier frequency control, while a pinion on the worm shaft drives the direct-reading main frequency dial by means of its internally cut spur gear. Eleven turns of the vernier dial rotate the rotor through 180° and the main dial through 264°.

## 2.3 ATTENUATOR

The pickup or output coupling loop on the piston of the mutual-inductance-type attenuator is coupled directly to the radio-frequency field of the butterfly oscillator as shown in Figure 4 or Figure 6. The attenuator tube is located just below the oscillator tuned circuit and extends through the casting base to the rear compartment which houses the frequency and attenuator drive mechanisms. A simple electrostatic shield (or mode suppressor) is mounted at the input end of the attenuator tube, so that, except for a short distance near the input end, the radio-frequency energy is attenuated at the rate of 32 db per tube diameter. The attenuator tube has an inside diameter of .600 inch in the 250 - 920 Mc unit and .880 inch in the 50 - 250 Mc unit. To attenuate 1 volt to .5 microvolt (126 db), therefore, the pickup loop must be moved 2.36 inches in the first case and 3.46 inches in the latter. The attenuator dial, which drives the attenuator piston by means of a rack and pinion, is calibrated in accordance with this law.

## 2.4 OUTPUT SYSTEM

One end of the attenuator pickup loop is grounded through a 50-ohm terminating resistor, and the other end is connected to a short length of 50-ohm flexible shielded lead which connects to the Type 874-VR Crystal Voltmeter Rectifier mounted at the lower right-hand corner of the panel. The voltmeter unit is built into a coaxial T-section and the r-f output voltage is measured at a point just ahead of the 50-ohm cylindrical terminating resistor in the center conductor of the output connector. The rectified output of the crystal drives the output voltmeter located on the power supply panel.

The voltage readings on the meter and attenuator dial are open-circuit voltages. Thus, the correct value of voltage appearing across a matched, 50-ohm load is obtained by dividing the meter or attenuator dial reading by two. The voltage appearing across an arbitrary load impedance of value $Z_L$ is $E\left(\frac{Z_L}{Z_L + 50}\right)$, in which E is the reading of the meter or the attenuator dial.

## 2.5 POWER SUPPLY UNIT

2.51 Power Supply: Essentially constant plate and filament voltages are supplied to the carrier oscillator by the power supply shown in Figures 7 and 8. The simple VR tube (V-3, V-4) circuit regulates plate voltage over a line voltage range of 105 to 125 volts or 210 to 250 volts at 50 to 60 cycles. The Amperite current regulator (V-1) maintains the heater voltage for the carrier oscillator. A portion of the regulated heater voltage is used as a calibrating source for the carrier voltmeter.

2.52 Modulation: The modulator circuit shown in Figures 7 and 8 consists of a single Type 6K6-GT tube (V-5) which is connected either as an L-C 1000-cycle oscillator for internal modulation or as a power amplifier for use when modulating with an external source. For 50% modulation it supplies about 50 volts r-m-s to the carrier-oscillator plate. The modulating voltage is controlled by the 100-kilohm rheostat R-10 on the right-hand side of the power supply panel. For internal modulation R-10 controls the output of the audio oscillator. For external modulation the control is switched to control the input to the amplifier.

2.53 Panel Meter: The panel meter can be switched to indicate either the d-c output from the carrier voltmeter rectifier or the d-c output from the germanium diodes of the modulation voltmeter.

## SECTION 3.0 OPERATION

### 3.1 POWER SUPPLY

The instrument is supplied complete with tubes and is ready for operation.

The line voltage and frequency are indicated on the name plate below the power input receptacle. The power-line-frequency range is 50 to 60 cycles. The voltage range is either 105 to 125 or 210 to 250 volts. If it is desired to change from a 105 - 125 volt condition to a 210 - 250 volt condition, or vice versa, change the power transformer connections as shown in Figure 7, reverse the nameplate to indicate the appropriate line voltage and replace the fuses as specified in the parts list. The fuses are mounted on the transformer terminal plate; 1 ampere fuses are required for 115 volt operation and 0.5 ampere fuses for 230 volt.

The power supply will not operate unless one of the two r-f oscillators is connected by means of the interconnecting cable.

### 3.2 FREQUENCY CONTROL

The only frequency control is the vernier-drive knob on the six-inch diameter main frequency dial. The frequency range of 250 to 920 Mc or 50 to 250 Mc is covered in 270° rotation of the main frequency dial and eleven turns of the vernier knob.

### 3.3 METER ZERO

With the power off, the meter should indicate zero. If it does not, it can be adjusted to zero by means of the screw-driver adjustment on the meter (mechanical zero adjustment). This is the only meter zeroing required since the panel meter indicates on dc from crystal rectifiers for either modulation or carrier voltage.

### 3.4 CARRIER VOLTMETER STANDARDIZATION

With the METER READS switch in the CARRIER position, the carrier voltmeter can be standardized at 0.5 volt by depressing the PUSH TO CAL. switch and adjusting the CALIBRATE knob until the meter reads at the red line at 0.5 volt. Depressing the PUSH TO CAL. switch removes plate voltage from the carrier oscillator and applies 0.5 volt, 60 cycles across the voltmeter rectifier. The attenuator setting does not affect this procedure but a load which generates an appreciable terminal voltage will cause the meter to deflect and hence upset the meter calibration. Such a load, which might be a heterodyne receiver with a strong local oscillator, should have its source of voltage shut off during standardization.

The 60-cycle impedance of the load has a small effect on the standardizing voltage which can be neglected ordinarily. The standardizing voltage rheostat (R-102 or R-203) has been set for a 50-ohm load, and the error for open or shorted conditions is $\pm 1\%$.

Standardization of the carrier voltmeter should be repeated from time to time to compensate for changes of the Type 1N21-B crystal detector which may be caused by ageing, by overloads, or by changes in temperature and humidity.

### 3.5 SETTING OF OUTPUT VOLTAGES BETWEEN 0.5 AND 2 VOLTS

After the carrier voltmeter has been standardized, output voltages between 0.5 and 2 volts can be set directly by adjusting the ATTENUATOR until the output meter reads the desired value with the load connected. A load which generates an appreciable terminal voltage should have its source of voltage shut off when the meter is read.

Changes in carrier frequency and load impedance will change the output voltage and the carrier voltmeter reading. After every change the desired meter reading has to be restored by turning the attenuator dial.

### 3.6 ATTENUATOR STANDARDIZATION

With the signal generator operating at the desired frequency, with the load connected and with the meter reading carrier output voltage, adjust the carrier output level by means of the ATTENUATOR knob until the meter reads 0.5 volt. Then move the adjustable attenuator index until it lines up with the red line at 0.5 volt on the attenuator dial. Meter and attenuator dial now read alike at 0.5 volt and the attenuator is standardized for the particular frequency and load. A load which generates an appreciable terminal voltage should have its source of voltage shut off when the meter is read.

### 3.7 SETTING OF OUTPUT VOLTAGES BELOW 0.5 VOLT

Output voltages below 0.5 volt can be set by turning the ATTENUATOR dial until the desired value appears under the attenuator index. As the output level is decreased, the reading of the output meter is gradually decreased to zero.

Changes in carrier frequency and load impedance will change the output voltage, but, at low output levels, this change cannot be observed on the output meter. After every change the attenuator has to be standardized again at 0.5 volt.

Sometimes, particularly in circuits employing tubes and rectifier crystals, the load impedance changes with the voltage applied. This change occurs at higher voltage levels and may make it impossible to standardize the attenuator at 0.5 volt as long as the voltage on the load is equally high. If this condition is suspected, the attenuator can still be standardized at 0.5 volt if addi-

tional attenuation is inserted between the signal generator output terminal and the load. The Type 874-GF 20db Attenuator is recommended for this purpose.

## 3.8 OUTPUT IMPEDANCE

As long as the attenuator is standardized for each frequency and load change, the effective output impedance of the Type 1021-A Standard-Signal Generator is 50 ohms. Maintaining a constant voltage level at the reference point produces an effective impedance of zero at the output voltmeter and the output impedance of the standard-signal generator is determined by the terminating resistor at the output terminal. (See Figure 1.)

## 3.9 MODULATION

3.91 Amplitude Modulation of the Type 1021-A: Internal amplitude modulation at 1000 cycles, external amplitude modulation (30c - 15Kc), or no modulation may be selected by the MODULATION switch. With the METER READS switch at MODulation, the modulation level is indicated on the meter and can be adjusted by means of the MODULATION control to obtain any degree of modulation up to 50%.

To obtain more accurate settings of the modulation level, the PUSH TO CAL. switch should be depressed while reading the modulation meter.

Approximately 12 volts across 100 kilohms is required from the external modulating oscillator for 50% modulation.

The Type 1021-A Standard-Signal Generator is normally amplitude-modulated by superimposing modulating voltages on the plate supply of the oscillator tubes. Incidental frequency modulation inherent with this method of modulation (see specifications) is relatively small, but may still be excessive for some applications. Amplitude modulation free of incidental fm can be obtained with auxiliary equipment at the output of the signal generator.

3.92 Television Modulator: In the Type 1000-P6 Crystal Diode Modulator[1], the resistance of a Type 1N21-B crystal is varied by modulating-frequency voltages. As a consequence, the radio-frequency output of a Type 1021-A Standard-Signal Generator can be amplitude modulated with no incidental fm if the Type 1000-P6 Modulator is inserted ahead of the load. The modulating-frequency characteristic is flat from zero up to several megacycles and it is down only 2 db at 5 megacycles. A convenient source of video modulation voltages is a television receiver tuned to a local station. The Type 1000-P6 Modulator is fitted with Type 874 coaxial terminals for the input and output connections and for the modulation circuit. The modulation range is from zero to about 50%. The modulator is designed to operate from a 50-ohm source into a 50-ohm load. To avoid distortion, the radio-frequency input to the crystal modulator must be limited to 50 millivolts. The insertion loss is approximately 12 db over the radio-frequency range of 20 - 1000 Mc.

## 3.10 OUTPUT CONNECTION

The new Type 874 Coaxial Connectors designed especially for u-h-f work are used as the output terminals on this signal generator. A Type 874-R20 3-foot Coaxial 50-Ohm Patch Cord and a Type 874-C Cable Connector are supplied to facilitate transmission of the output signal to equipment under test.

Type 874 Adaptors are available for connection to systems using Type N, Type BNC, Type C, and Type U-H-F Connectors, the older General Radio Type 774 Coaxial Terminals, and General Radio Type 274 Plugs and Jacks.

Many other Type 874 accessories are available which are useful in extending the utility of the Type 1021-A Standard-Signal Generator in measurements of voltage, power, and standing wave ratios.

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[1] W.F. Byers, "An Amplitude Modulator for Video Frequencies," General Radio Experimenter, March, 1950.

## SECTION 4.0 MAINTENANCE

### 4.1 INPUT POWER

Power input for a Type 1021-A Standard-Signal Generator is about 50 watts at 115 volts on a 60-cycle line.

### 4.2 TUBES, PILOT LIGHT AND FUSES

Locations of vacuum tubes, pilot light and fuses are as follows:

Type 1021-P2 U-H-F Oscillator Unit 250 - 920 Mc

V-200 Sylvania Type RT-434 Oscillator
Mounted on tuned circuit on upper side of oscillator casting within two cylindrical shield cans.

RX-201 1N21-B Rectifier crystal for rf
Mounted in output voltmeter unit back of output terminal.

Type 1021-P3 V-H-F Oscillator Unit 50 - 250 Mc

V-100 G.E. 12AT7 Oscillator
Mounted on tuned circuit on upper side of oscillator casting within two cylindrical shield cans.

RX-101 1N21-B Rectifier crystal for rf
Mounted in output voltmeter unit back of output terminal.

Type 1021-P1 Power Supply

V-1 AMPERITE 6-4 Heater Regulator
V-2 6X5-GT/G Rectifier
V-3 0C3/VR-105 Regulator
V-4 0C3/VR-105 Regulator
V-5 6K6-GT/G Modulator
Mounted on power supply shelf. Location of each is indicated in Figure 9.

RX-1 1N34 rectifier crystal for modulation
RX-2 1N34 rectifier crystal for modulation
Mounted on resistor strip.

P-1 2LAP-939 Mazda #44 6 - 8 volt
Mounted on panel.

F-1 1 amp SLOW BLOW Type 3AG
F-2 1 amp SLOW BLOW Type 3AG } 115 v.

F-1 .5 amp SLOW BLOW Type 3AG
F-2 .5 amp SLOW BLOW Type 3AG } 230 v.
Mounted on power transformer terminal plate.

### 4.3 REPLACING R-F OSCILLATOR TUBES

If the output of the r-f oscillator is reduced after many hours of use and particularly if the maximum obtainable output is no longer sufficient to standardize the attenuator at 0.5 volt, the r-f oscillator tube then has to be replaced. After replacing the tube a number of adjustments may be required to restore the frequency calibration and to insure that the new tube is operating properly.

4.31 Replacing Oscillator Tube in 250 - 920 Mc Unit:

(a) To Replace Tube: Remove the two concentric shield cans on top of casting. Loosen two small screws on grid and plate clamp-type terminals and remove old tube. Insert new tube and tighten plate and grid clamps to hold the tube securely, but not enough to endanger the glass-to-metal seals of the tube. Check the heater voltage directly at the tube terminals. It should be 6.3 volts ±5%. For this measurement, turn off plate voltage by depressing PUSH TO CAL. switch. If not within limits, see Paragraph 4.5.

(b) Frequency Adjustment: At the top frequency setting of the oscillator, the tube grid-to-plate capacitance, which varies slightly from tube to tube, is a considerable portion of the total tuning capacitance, hence, the top frequency obtained will vary with tube changes. The trimmer capacitance, C-208, the soft-copper tab on the plate connector, is provided to allow adjustment for tube changes. If frequency measuring equipment is available, the oscillator frequency can be reset to agree with dial at a setting of 920 Mc. The inner shield can should be in place when frequency is measured.

(c) Plate Current: With a milliammeter in series with the oscillator plate supply lead, adjust R210 (screw driver control on the main casting near the output cable) so that plate current is 30 ma or less as oscillator is tuned through its whole range.

4.32 Replacing Tube in 50 - 250 Mc Unit:

(a) To Replace Tube: Remove the two concentric shield cans on top of casting. The tube is located between the tuned circuit and its base casting and is on the right-hand side when one faces the panel. Remove the small hold-down clamp which is fastened to the casting with two screws. The tube can now be removed from the conventional nine-pin miniature socket. A new tube is easily inserted and the hold-down clamp should be replaced. Check the heater voltage directly at the tube terminals. It should be 6.3 volts ±10%. Turn off oscillator plate voltage, for this measurement, by depressing PUSH TO CAL. button. If not within limits, see Paragraph 4.5.

(b) Frequency Adjustment: At the top frequency setting of the oscillator, the tube grid-to-plate capacitance, which varies from tube to tube, is a considerable portion of the total tuning capacitance; hence, the top frequency obtained may vary with tube changes. The trimmer capacitance C-110, the small slotted rectangular plate spanning the gap in the top stator plate, is provided to allow adjustment for tube changes. If frequency

measuring equipment is available, the oscillator frequency can be reset to agree with the dial at a setting of 250 Mc. The inner shield should be in place when frequency is measured.

(c) Plate Current: With a milliammeter in series with the plate supply lead, adjust R-108 (screw-driver control in bottom of lower casting well) so that plate current is 25 ma or less as oscillator is tuned through its whole range. Inner shield can should be in place for the adjustment.

## 4.4 REPLACING RECTIFIER CRYSTAL

If the carrier output meter cannot be standardized according to the procedure outlined in Paragraph 3.4, the 60-cycle calibrating voltage may not be correct (see Paragraph 4.5) or the voltmeter crystal may be damaged and may have to be replaced. To remove the crystal from the output voltmeter: disconnect, by removing the small screw, the voltmeter output lead which is located back of the panel just below the PUSH TO CAL. switch; remove, by turning counter-clockwise, the voltmeter cap on which the output terminal is located. The crystal cartridge can now be removed by loosening the small spring clamp which holds it in place. A good 1N21-B crystal will have a forward resistance of less than 1000 ohms and a back resistance of greater than 10,000 ohms when measured with a Weston Model 663 Voltohmmeter on the R x100 range or an equivalent ohmmeter which operates from a 1.5-volt battery.

## 4.5 REPLACING REGULATOR TUBE V-1 IN HEATER SUPPLY

If the heater voltage as specified in Paragraphs 4.31(a) or 4.32(a) is not correct, it may be in error due to a defective V-1 regulator tube (the Amperite 6-4) or due to a change in the series resistors R-102 and R-103 in the 50 - 250 Mc oscillator (R-202 and R-203 in the 250 - 920 oscillator). The resistance values should be verified before the 6-4 tube is replaced.

If the Amperite 6-4 heater regulator (V-1) or the r-f oscillator tube (V-200 or V-100) is changed, heater currents may change enough to affect the 0.5 volt voltmeter calibrating source. This can be checked by measuring the 60-cycle voltage appearing at the Type 874-VR Output Terminal, on the panel just below the PUSH TO CAL. switch, with a reliable vacuum-tube voltmeter such as the General Radio Type 1800-A, when the PUSH TO CAL. button is depressed. Any necessary adjustment may be made with screw-driver adjustment of R-203 or R-103 mounted on the resistor strip just above the PUSH TO CAL. switch.

| RESISTORS | | | | TYPE |
|---|---|---|---|---|
| R-100 = | 5.1 K Ohms | ± 5% | | REW-6C |
| R-101 = | 5.1 K Ohms | ± 5% | | REW-6C |
| R-102 = | 10 Ohms | ± 5% | | REW-6C |
| R-103 = | 10 Ohms | ±10% | | POSW-862 |
| R-104 = | 5.1 K Ohms | ± 5% | (AB) Type EB | REC-21BF |
| R-105 = | 10 Ohms | ± 5% | (AB) Type EB | REC-21BF |
| R-106 = | 10 Ohms | ± 5% | (AB) Type EB | REC-21BF |
| R-107 = | 5.1 K Ohms | ± 5% | (AB) Type EB | REC-21BF |
| R-108 = | 1 K Ohm | ±10% | | POSC-11 |
| R-109 = | 150 Ohms | ± 5% | (AB) Type EB | REC-21BF |
| R-110 = | 39 Ohms | ± 5% | (AB) Type EB | REC-21BF |
| R-111 = | 50 Ohms | ± 1% | (Part of RX-100) | REU-10 |
| R-112== | 5.1 Ohms | ±10% | | REW-3C |
| R-113 = | 47 k Ohms | ±10% | | REC-41BF |

| CONDENSERS | | TYPE |
|---|---|---|
| C-100 = | 16 μf 150 D.C. W.V. | COE-4 |
| C-101 = | 100 μμf | COU-8-2 |
| C-102 = | 2000 μμf | COU-10 |
| C-103 = | 200 μμf | COU-8-2 |
| C-104 = | 200 μμf | COU-8-2 |
| C-105 = | 2000 μμf | COU-10-2 |
| C-106 = | 2000 μμf | COU-10-2 |
| C-107 = | 1000 μμf ±20% (El.Reactance Corp.) "HI-K" | GP.CN-1 |
| C-108 = | 5 μμf ±0.5μμf (El.ReactanceCorp.) "HI-Q" | CC-20CG050D |
| C-109 = | 5 μμf ±0.5μμf (El.ReactanceCorp.) "HI-Q" | CC-20CG050D |
| C-110 = | Built in (Air) Trimmer | |
| C-111 = | 1000 μμf (Part of LC-101) | 1021-214 |
| C-112 = | 1000 μμf (Part of LC-101) | COU-25 |
| C-113 = | 300-400 μμf Built In (Part of RX-100) | |

| CHOKES | | TYPE |
|---|---|---|
| L-100 = | 185 μh | ZCHA-30 |
| L-101 = | 185 μh | ZCHA-30 |
| L-102 = | 20 μh | ZCHA-29 |
| L-103 = | 20 μh | ZCHA-48 |
| L-104 = | Atten. Loop (Part of Atten.) | |
| L-105 = | 2 μh (Part of LC-101) | ZCHA-37 |
| L-106 = | 185 μh | ZCHA-30 |

| MISCELLANEOUS | | |
|---|---|---|
| LC-100 = | Butterfly 44-250 Mc | Built in |
| LC-101 = | Filter | 1021-302 |
| PL-100 = | Plug | CDMP-1264-8 |
| S-100 = | T.P.D.T. | SWP-3 |
| RX-100 = | Voltmeter Rectifier | 874-309 |
| RX-101 = | Rectifier 1N21B | (Part of RX-100) |

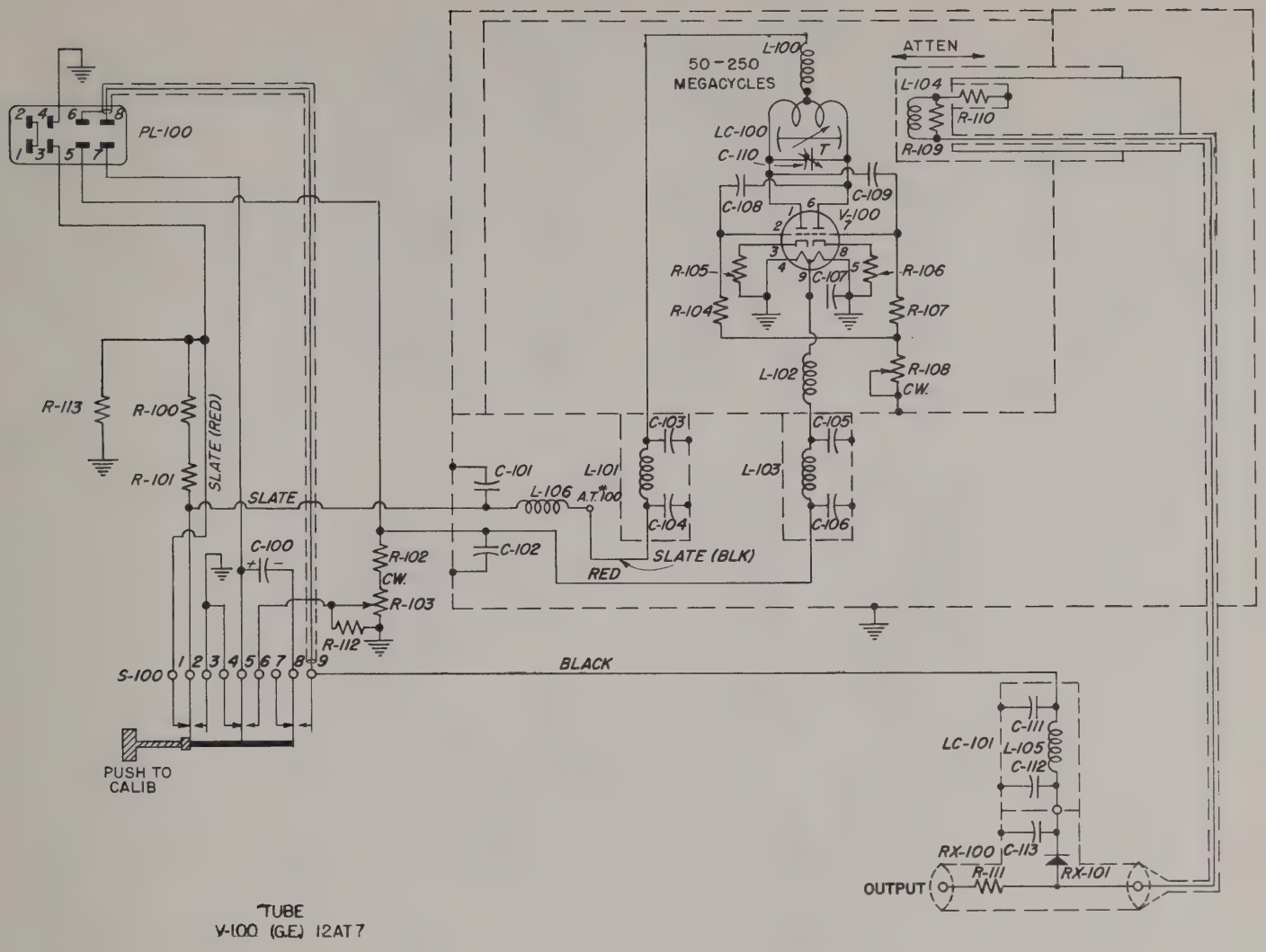


Figure 3. Wiring Diagram for Type 1021-P3 V-H-F Unit.

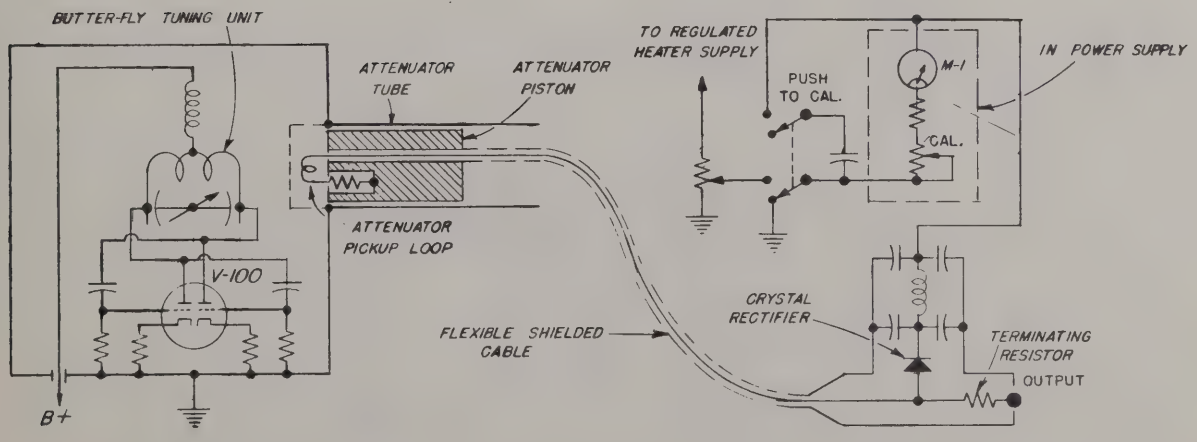


Figure 4. Schematic Diagram for Type 1021-P3.

| RESISTORS | | | TYPE |
|---|---|---|---|
| R-200 = | 5.1 K Ohms | ±10% | REW-6C |
| R-201 = | 5.1 K Ohms | ±10% | REW-6C |
| R-202 = | 24 Ohms | ± 5% | REW-6C |
| R-203 = | 10 Ohms | ±10% | POSW-862 |
| R-205 = | 1.0 K Ohms | ±10% | REC-21BF |
| R-206 = | 50 Ohms | ± 2% | REC-21BF |
| R-207 = | 50 Ohms (Part of RX-200) | ± 1% | REU-10 |
| R-208 = | 5 K Ohms | ±10% | POSW-862 |
| R-209 = | 5.1 Ohms | ±10% | REW-3C |
| R-210 = | 2500 Ohms | ±10% | POSC-11 |
| R-211 = | 1 K Ohm | ±10% | REW-6C |

| CONDENSERS | | TYPE |
|---|---|---|
| C-200 = | 16 μf 150 D.C. W.V. | COE-4 |
| C-201 = | 100 μμf | COU-8-2 |
| C-202 = | 500 μμf | COU-8-2 |
| C-203 = | 200 μμf | COU-8-2 |
| C-204 = | 200 μμf | COU-8-2 |
| C-205 = | 500 μμf | COU-8-2 |
| C-206 = | 500 μμf | COU-8-2 |
| C-207A = | Built in (Air) Adj. | |
| C-207B = | Built in (Air) Adj. | |
| C-208 = | Built in (Air) Adj. | |
| C-209 = | 10 μμf Built in (Mica) | |
| C-210 = | 1000 μμf (Part of LC-201) | 1021-214 |
| C-211 = | 1000 μμf (Part of LC-201) | COU-25 |
| C-212 = | 300-400μμf Built in (Mica)(Part of RX-200) | |

| CHOKES | | TYPE |
|---|---|---|
| L-200 = | 45 μh | ZCHA-9 |
| L-201 = | 45 μh | ZCHA-9 |
| L-204 = | 20 μh | ZCHA-48 |
| L-205 = | 45 μh | ZCHA-9 |
| L-206 = | Atten. Loop (Part of Atten.) | |
| L-207 = | 2 μh (Part of LC-201) | ZCHA-37 |
| L-208 = | 45 μh | ZCHA-9 |

| MISCELLANEOUS | | |
|---|---|---|
| LC-200 = | Butterfly 250-920 Mc | Built in |
| LC-201 = | Filter | 1021-302 |
| LR-1 = | Heater Filter | 1021-216 |
| PL-200 = | Plug | CDMP-1264-8 |
| S-200 = | T.P.D.T. | SWP-3 |
| RX-200 = | Voltmeter Rectifier | 874-309 |
| RX-201 = | Rectifier (Part of RX-200) | 1N21-B |

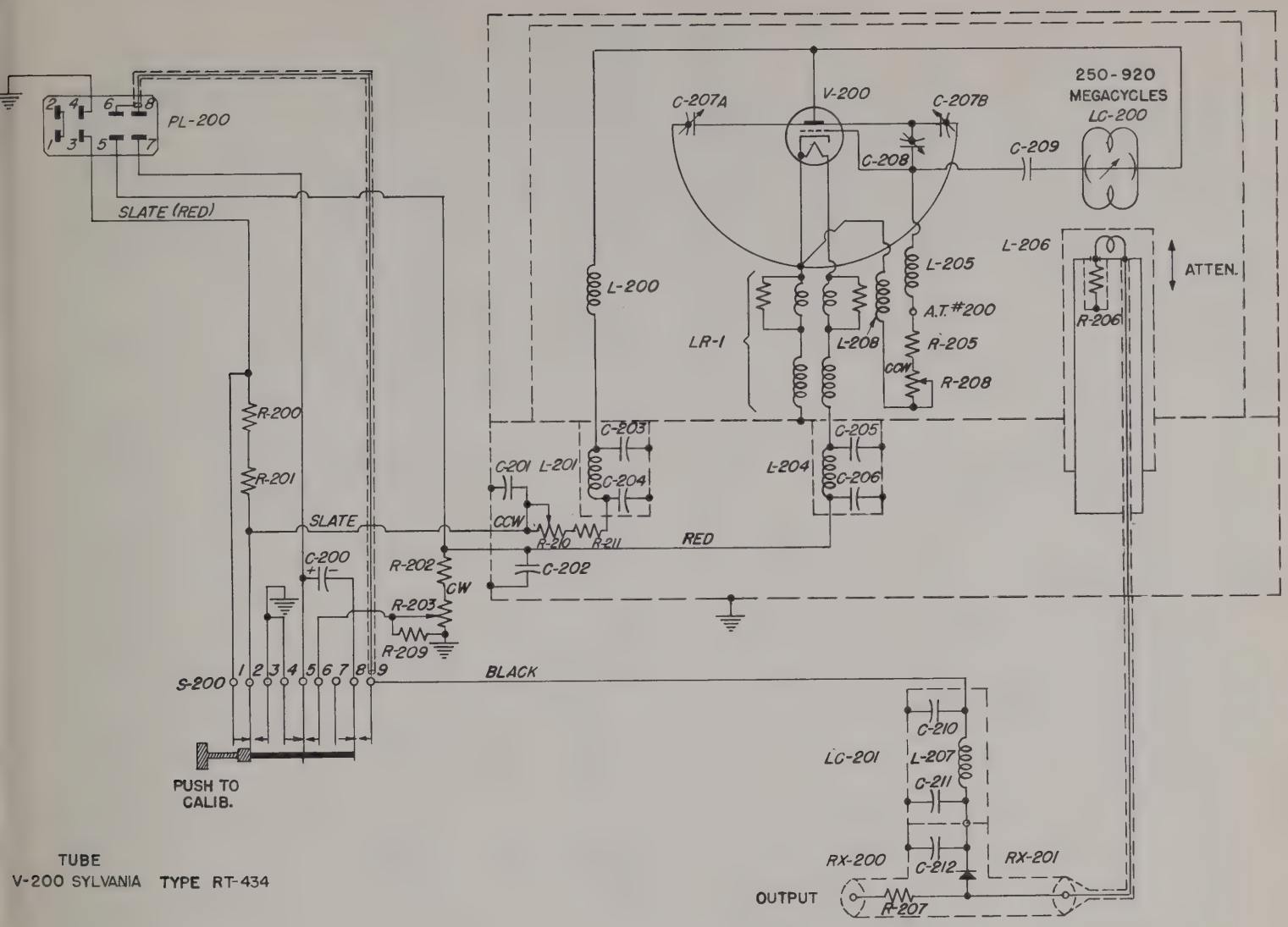


Figure 5. Wiring Diagram for Type 1021-P2 U-H-F Unit.

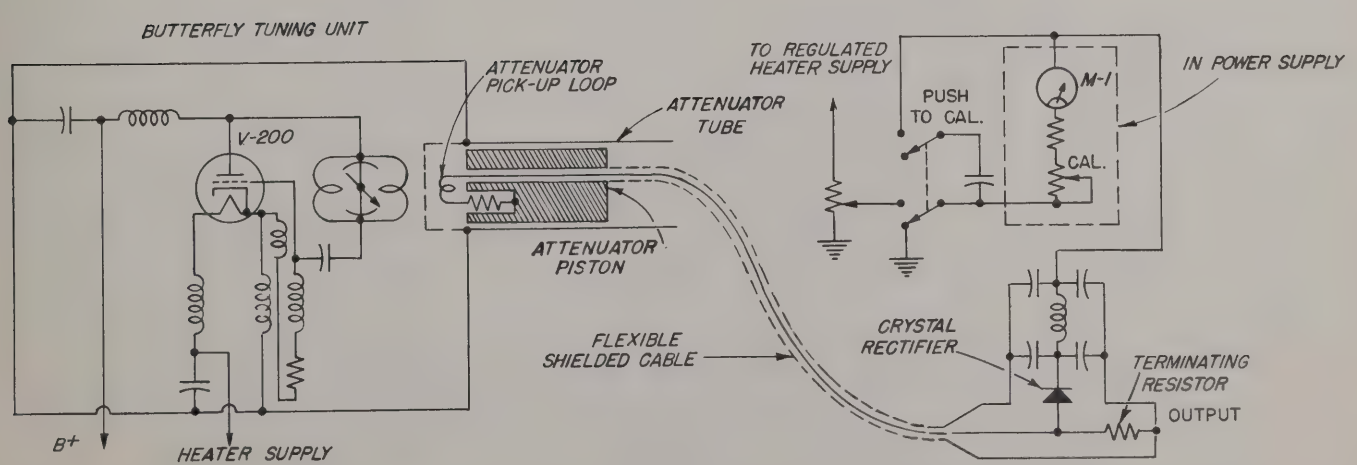


Figure 6. Schematic Diagram for Type 1021-P2.

## RESISTORS

| | | | | | TYPE |
|---|---|---|---|---|---|
| R1 | = | 33 | K Ohms | ± 5% C.C.Co. | X-1/2 |
| R2 | = | 33 | K Ohms | ± 5% C.C.Co. | X-1/2 |
| R3 | = | 2.5 | K Ohms | ±10% | POSW-3 |
| R4 | = | 100 | K Ohms | ± 5% C.C.Co. | X-1/2 |
| R5 | = | 5.6 | K Ohms | ±10% C.C.Co. | X-1/2 |
| R6 | = | 10 | K Ohms | ± 5% | 301-A |
| R7 | = | 900 | Ohms | ±10% | REPO-33 |
| R8 | = | 900 | Ohms | ±10% | |
| R9 | = | 100 | Ohms | ±10% | REW-3C |
| R10 | = | 100 | K Ohms | ± 5% | 314-A |
| R11 | = | 330 | Ohms | ± 5% | REW-3C |
| R12 | = | 270 | Ohms | ± 5% | REW-3C |
| R13 | = | 750 | Ohms | ± 5% | REW-4C |
| R14 | = | 1 | Megohm | ±10% | REC-21BF |
| R15 | = | 1800 | Ohms | ±10% | REC-41BF |
| *R16 | = | 15 | Ohms | ±10% | REW-3C |
| R17 | = | 180 | Ohms | ±10% | REW-3C |
| R18 | = | 180 | Ohms | ±10% | REW-3C |
| R19 | = | 500 | Ohms | ±10% | POSW-3 |

*Part of P1 Socket

## CONDENSERS

| | | | | | TYPE |
|---|---|---|---|---|---|
| C1 | = | .15 | µf | ±10% | COL-57 |
| C2 | = | .01 | µf | ±10% | COM-35B |
| C3 | = | .01 | µf | ±10% | COM-35B |
| C4 | = | 20 | µf | 450 W.V. | COEB-25 |
| C5 | = | 20 | µf | 450 W.V. | |
| C6 | = | 20 | µf | 450 W.V. | |
| C7 | = | 20 | µf | 450 W.V. | |
| C8 | = | .02 | µf | ±10% | COL-33 |
| C9 | = | .15 | µf | ± 5% ** | COL-57 |
| C10 | = | .15 | µf | ±10% | COL-57 |
| C11 | = | .15 | µf | ±10% | COL-57 |

** Select to ±5%

| | | | | | |
|---|---|---|---|---|---|
| C12 | = | .1 | µf | ±10% | COL-71 |

## MISCELLANEOUS

| | | | | |
|---|---|---|---|---|
| T1 | = | Transformer | | 485-459 |
| L1 | = | Choke | | 485-458 |
| L2 | = | Oscillator Coil | | 746-412 |
| S1 | = | DPDT | | SWT-335 |
| S2 | = | DPST | | SWT-333 |
| S3 | = | 8P-3Position | | SWRW-50 |
| SO1 | = | 8 Blade Socket | | CDMS-1-8 |
| PL1 | = | 2 Blade Pwr. Plug | | CDPP-562A |
| RX1 | = | Crystal Rect. | | 1N34-A |
| RX2 | = | Crystal Rect. | | 1N34-A |
| | | For 115v. operation; | | |
| F1,F2 | = | 1 Amp Slow Blow 3AG | | GR#FUF-1 |
| | | For 230v. operation: | | |
| F1,F2 | = | 0.5 Amp. Slow Blow 3AG | | GR#FUF-1 |
| P1 | = | Pilot Light | 2LAP-939 | Mazda #44 |
| M1 | = | Meter (200 µa 600 Ω) | | MEDS-40 |

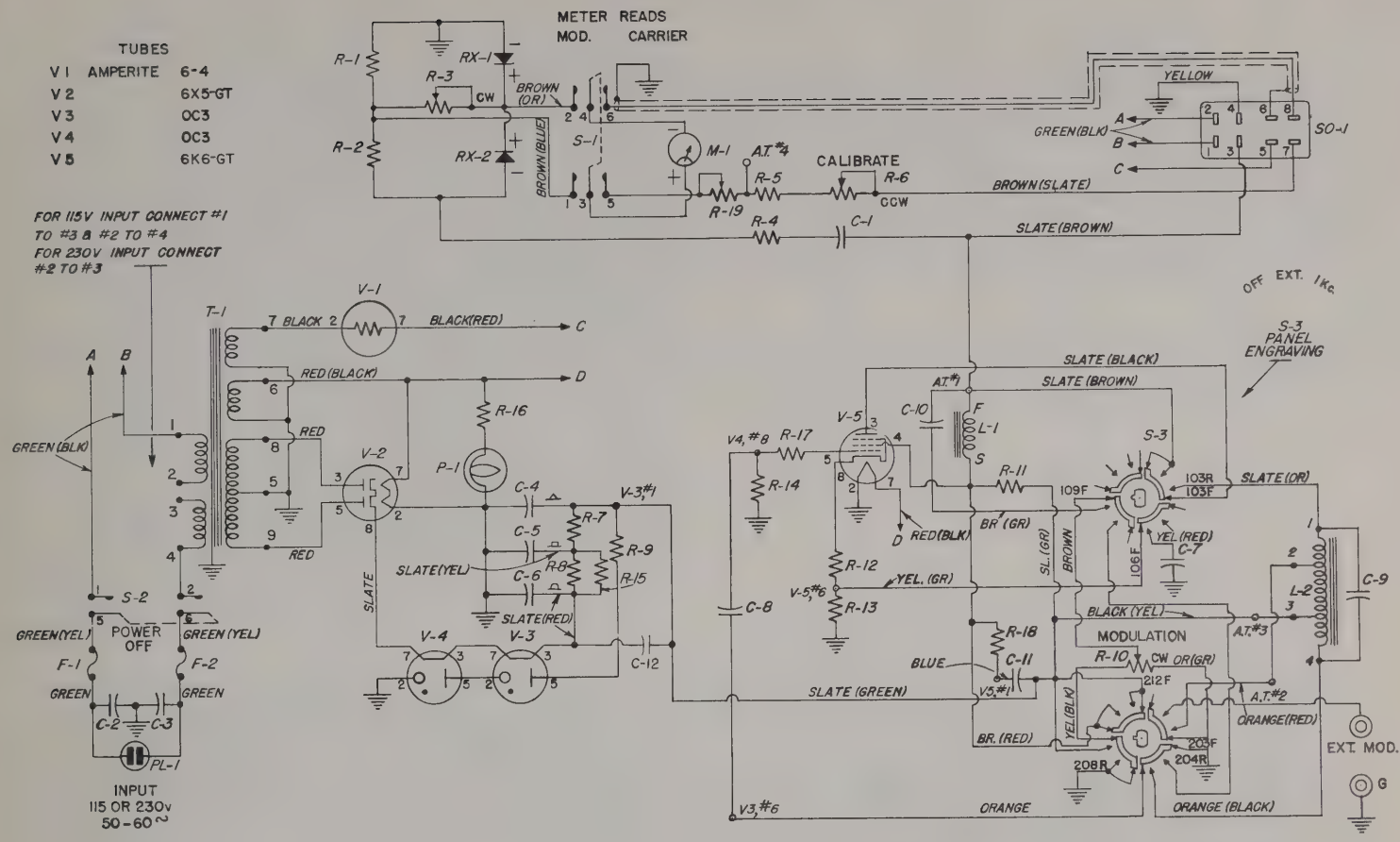


Figure 7. Wiring Diagram for Type 1021-P1 Power Supply.

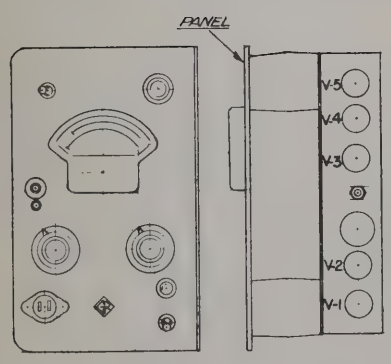


Figure 9. Vacuum Tube Layout for Type 1021-P1.

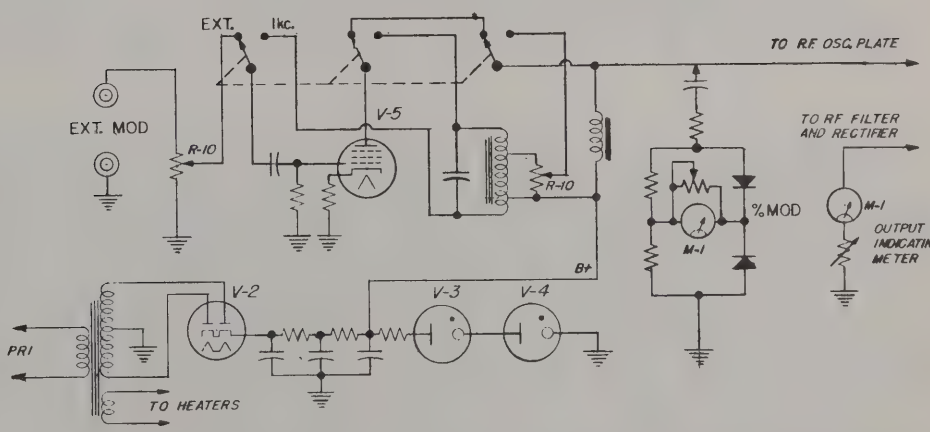


Figure 8. Schematic Diagram for Type 1021-P1.

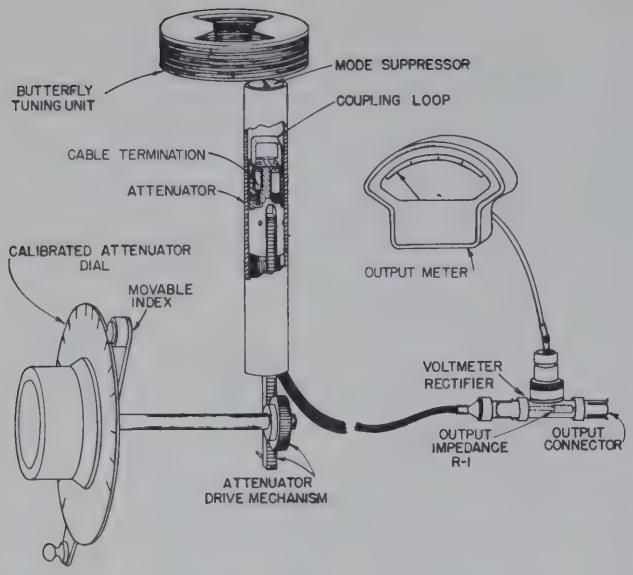


Figure 10. Functional diagram of the output system of the Type 1021-A Standard-Signal Generator.

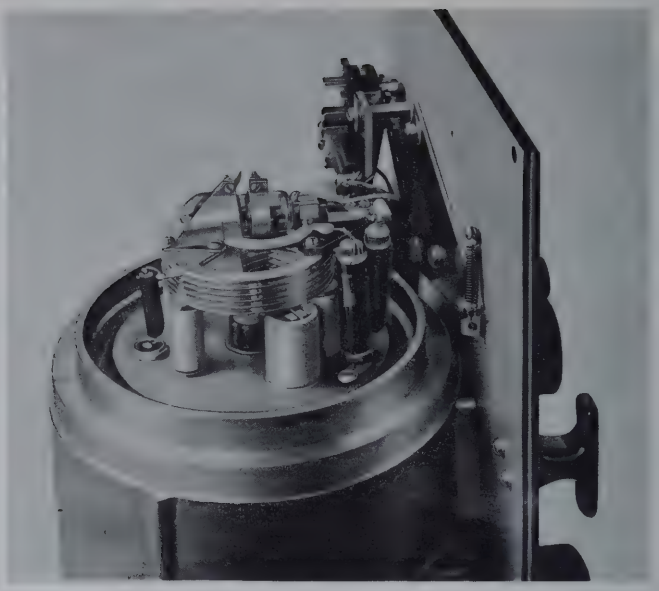

Figure 11. View of the oscillator portion of the U-H-F Unit, with cover removed from casting to show tube, butterfly, and attenuator input.

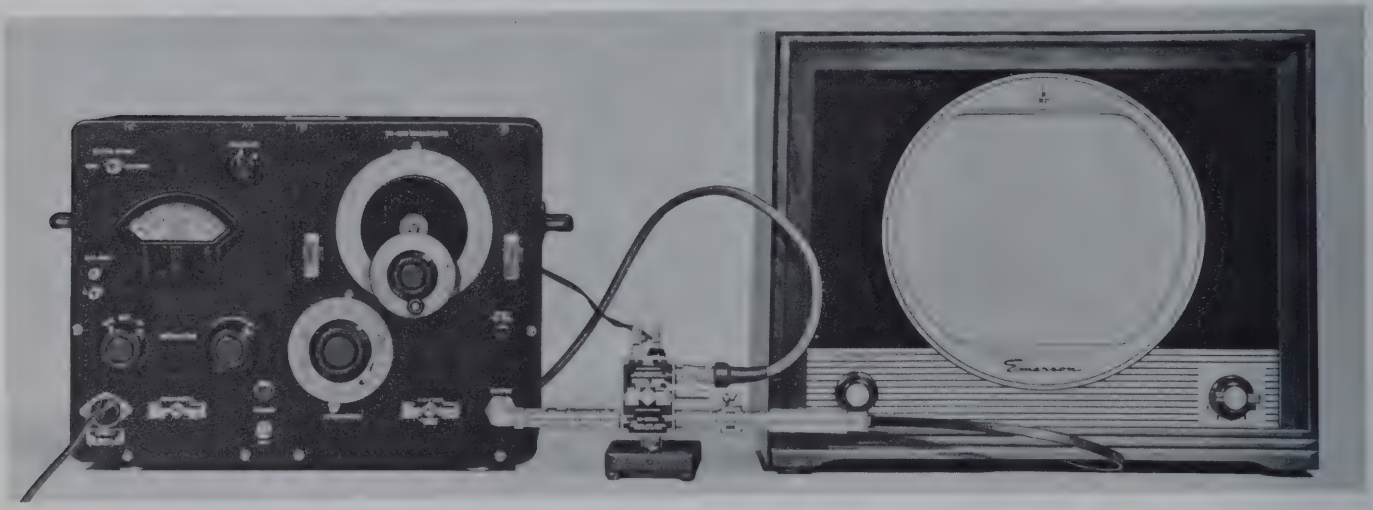

Figure 12. The Type 1021-AV V-H-F Standard-Signal Generator with the Type 1000-P6 Crystal Diode Modulator, set up for tests on a television receiver.

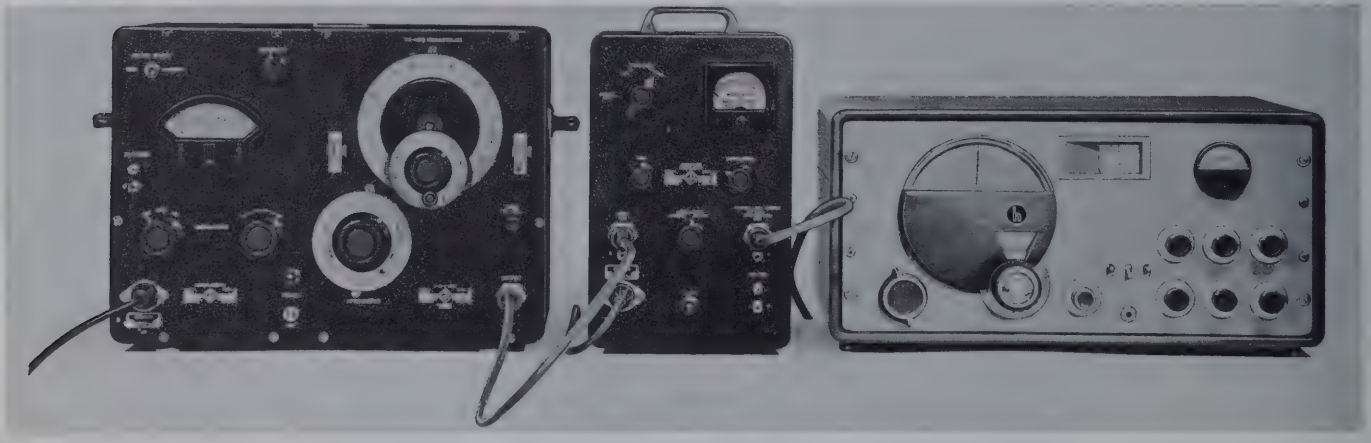

Figure 13. The Type 1021-AV V-H-F Standard-Signal Generator and the Type 1023-A Amplitude Modulator, arranged for tests on a communications-type receiver.

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ELECTRICAL MEASUREMENTS AND THEIR INDUSTRIAL APPLICATIONS

# A STANDARD-SIGNAL GENERATOR FOR FREQUENCIES BETWEEN 50 AND 920 MC

*Also*
IN THIS ISSUE

*Page*

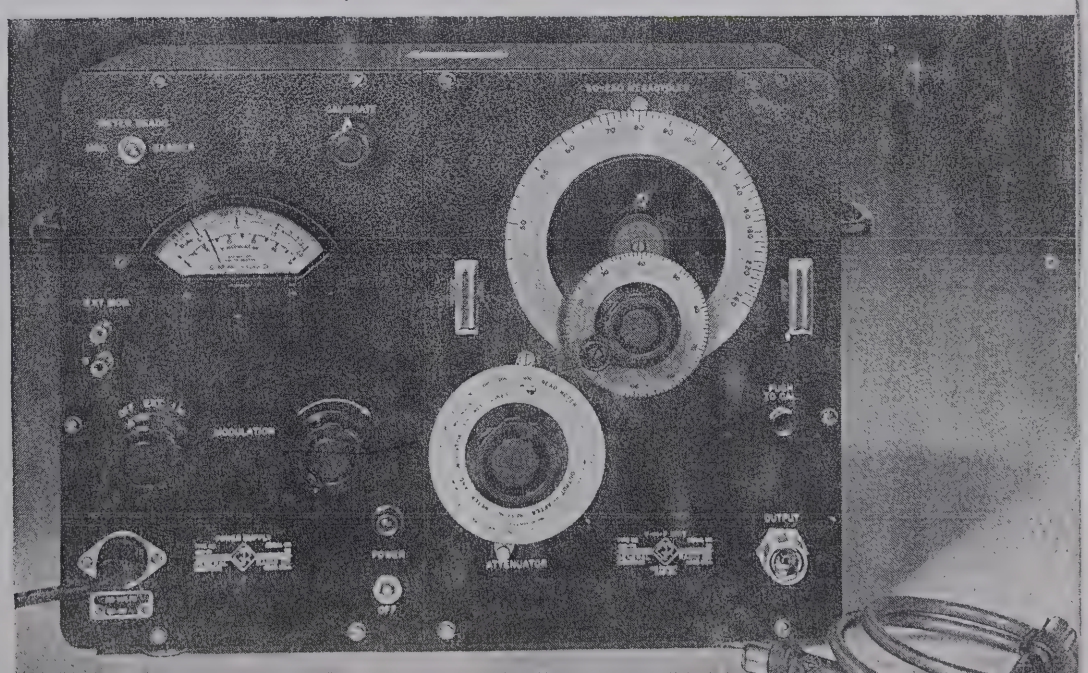
AN AMPLITUDE MODULATOR FOR VIDEO FREQUENCIES..... 6

●THE NEW TYPE 1021-A Standard-Signal Generator performs at very-high and ultra-high frequencies all the functions of the common standard-signal generator which is ordinarily limited to much lower frequencies. Its main use is the determination of radio-receiver and circuit characteristics in the engineering laboratory and in production. In addition it is a convenient and well-shielded source of power for measurements with bridges, impedance comparators, and slotted lines.

In combination with a simple crystal-diode modulator (TYPE 1000-P6) and a source of video signals, it can be used to produce television picture modulation on all channels between 50 and 920 Mc.

With the TYPE 1023-A Amplitude Modulator, the generator out-

Figure 1. Panel view of the Type 1021-AV V-H-F Standard-Signal Generator.



put, up to 250 Mc, can be modulated to a known percentage at audio frequencies with no significant incidental fm.

Internal amplitude modulation is provided for those uses where a small amount of incidental fm is not serious.

Simplicity, economy, and reliability were important design considerations, and the resulting instrument is moderately priced, compact, light in weight, durably built, and convenient to use. Since range switching is impractical at these frequencies, two separate oscillator units are used, each with its own attenuator and rectifier for measuring output voltage. The V-H-F Unit covers frequencies between 50 and 250 Mc, and the U-H-F Unit, 250 to 920 Mc. A third unit, the power supply assembly, provides filament and plate power, means for amplitude modulation at audio frequencies, and a meter for indicating output voltage and percentage modulation.

For convenience in ordering, the generator is listed in two models, (1) the TYPE 1021-AV V-H-F Standard-Signal Generator, consisting of the V-H-F Unit and power supply in a cabinet, and (2) the TYPE 1021-AU, consisting of the U-H-F Unit and power supply in a cabinet. When both ranges are desired, the TYPE 1021-AV can be ordered plus the additional U-H-F Oscillator Unit as a separate item. Oscillator units are interchangeable mechanically, and the replacement of one by the other is easily and quickly accomplished.

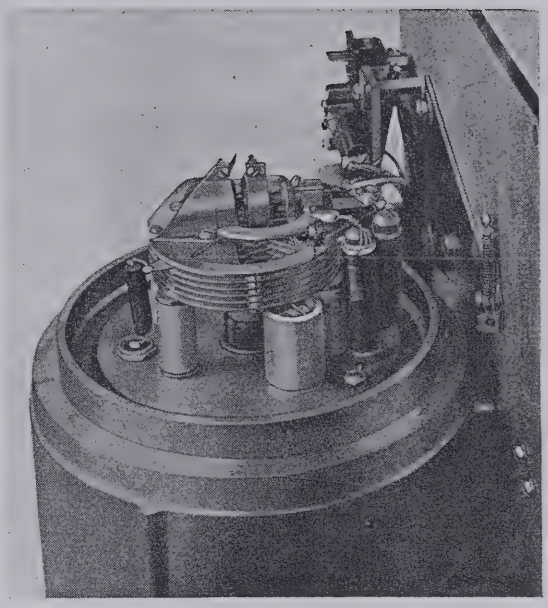


Figure 3. View of the oscillator portion of the U-H-F Unit, with cover removed from casting to show tube, butterfly, and attenuator input.

## R-F OSCILLATORS

Structurally, the two carrier oscillator units are much alike. They differ in carrier frequency range covered, but each uses as the tuning element a butterfly circuit[1,2], in which the inductive and capacitive components are built integrally, and tuning is achieved by simultaneous variation of both without use of sliding contacts. The U-H-F Unit uses a $2\frac{1}{2}''$ diameter symmetrical butterfly circuit adapted for use with the Sylvania Type 5767 Coplanar U-H-F Triode, or Rocket Tube, while the V-H-F Unit uses a $4\frac{1}{2}''$ semibutterfly with a standard miniature twin triode (12AT7) in a push-pull connection.

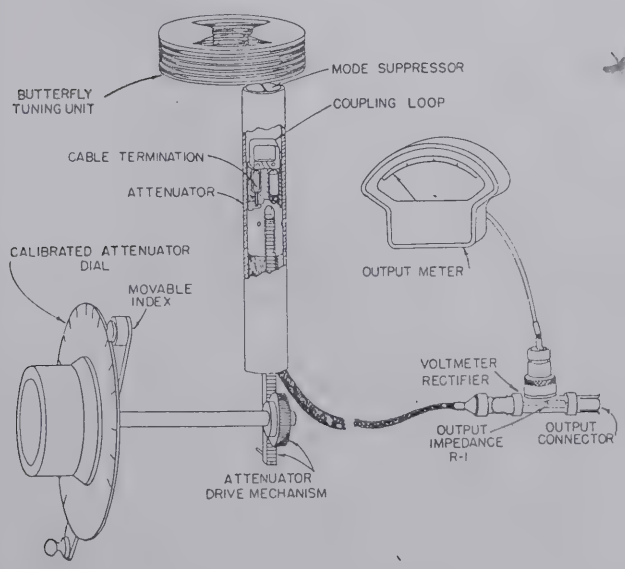



Figure 2. Functional diagram of the output system.

[1]Eduard Karplus, "The Butterfly Circuit," *General Radio Experimenter*, October, 1944.

[2]Eduard Karplus, "Wide-Range Tuned Circuits and Oscillators for High Frequencies," *Proceedings I. R. E.*, July, 1945.

## POWER SUPPLY UNIT

The power supply unit provides regulated plate and heater power for the oscillator. A modulator tube is connected in a simple *L-C* oscillator circuit to provide internal amplitude modulation at 1000 cycles per second, or as an amplifier to permit amplitude modulation over the audio frequency range. A single panel meter is used to indicate carrier output voltage and modulation percentage, and to check the calibration of the crystal detector used in the output meter. An internal calibrating voltage derived from the regulated power supply is provided for this check.

## OUTPUT SYSTEM

Output between 0.5 microvolt and 1.0 volt, at an internal output impedance of 50 ohms, is available at a coaxial connector on the panel. This output is obtained through a mutual inductance (waveguide-below-cutoff type) attenuator. A coaxial cable connects the attenuator to a crystal voltmeter on the front panel. Following the voltmeter is a 50-ohm resistor which determines the output impedance. The rectifying element of the voltmeter and its mounting are similar to the TYPE 874-VR Voltmeter Rectifier[3]. The indicating meter is in the TYPE 1021-P1 Power Supply Unit. At 920 Mc the voltmeter error caused by resonance is about +6%.

Voltages between 0.5 volt and 2 volts are indicated directly by the output meter. Since the meter is connected across the output of the attenuator, it will not read at low output voltage settings. For voltages under 0.5 v, the output is first set to 0.5 volt, as indicated by the meter, and the adjustable attenuator index is moved to the 0.5-volt point on the attenuator dial which is calibrated down to 0.5$\mu$v. Other low output voltages are then determined accurately by setting the attenuator dial, as long as the load is not changed. In this output system, the accuracy of output voltage at the panel terminal is determined by the accuracy of the voltmeter and attenuator alone, and the effective output impedance is determined by the resistor $R_1$. The resistor $R_2$ at the attenuator input is a matching resistance which prevents high-amplitude standing waves from being set up in the cable when the output is open circuited.

The output system used here differs from the more conventional arrangement[4, 5, 6] whereby the field at the attenuator input is sampled by a probe and indicated on a panel meter. The out-

[3]W. R. Thurston, "Simple, Complete, Coaxial Measuring Equipment for the U-H-F Range," *General Radio Experimenter*, January, 1950.

[4]Eduard Karplus, "Components of U-H-F Field Meters," *Electronics*, November, 1946.

[5]Arnold Peterson, "Output Systems of Signal Generators," *General Radio Experimenter*, June, 1946.

[6]D. B. Sinclair, "A Simple Standard-Signal Generator for F-M Broadcast Use," *General Radio Experimenter*, November, 1949.

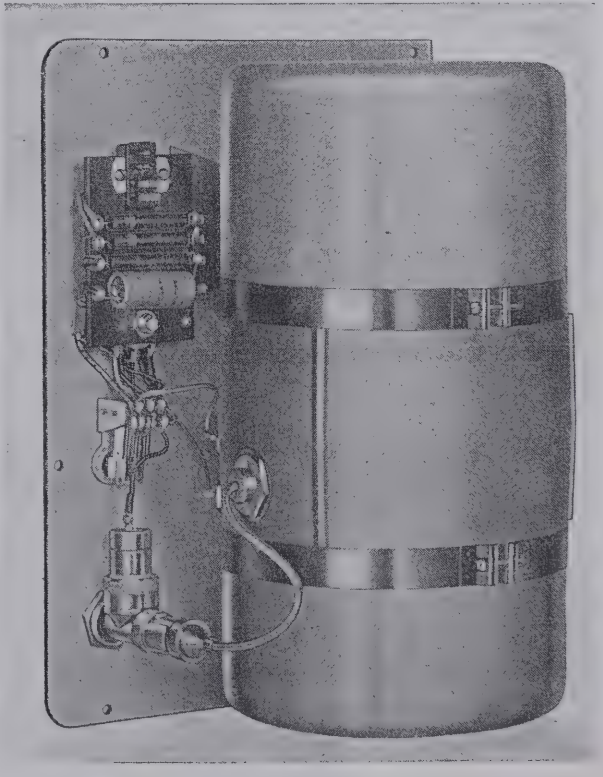


Figure 4. Rear view of the V-H-F Unit showing the casting that completely encloses the oscillator. Connections to the power supply unit are made through the connector at the upper right.

put voltage is then independent of load, and the internal impedance is that seen when looking back into the attenuator cable terminated in a coupling loop and resistor. Such a system can be made to work satisfactorily at frequencies up to a few hundred megacycles, but, at higher frequencies, both higher output voltages and more accurate voltage indications can be obtained with the system chosen for use in this generator.

## MODULATION

A general-purpose internal amplitude modulation system is provided, and external modulation can be applied, but no provision is made for pulsing or for frequency modulation.

In addition to its obvious uses in receiver testing, the modulated signal has a considerable advantage when the generator is used as a power source for impedance measurements with bridges, slotted lines, and admittance comparators, because it permits audio amplification to be used following the detector to increase sensitivity.

The oscillator is modulated directly, and consequently incidental fm is inherent in the system.

Where incidental fm cannot be tolerated, and where wide-band modulation is desired, external modulating units, operating on the output side of the attenuator, can be used. Because the modulator is isolated from the oscillator by the attenuator, reaction on the oscillator frequency, with its attendant incidental fm, is completely negligible. Two such external modulating units are available, the TYPE 1023-A Amplitude Modulator and the TYPE 1000-P6 Crystal Diode Modulator.

The TYPE 1023-A Amplitude Modulator[7] can be used at carrier frequencies up to 250 Mc and will give output up to 150 millivolts. Percentage modulation can be adjusted accurately up to a maximum of 80%.

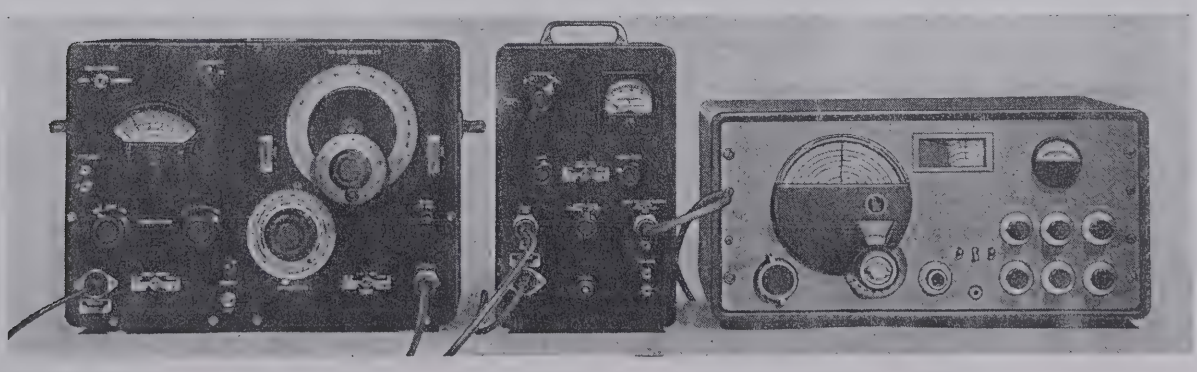
For amplitude modulation, without incidental fm, over the entire range of the TYPE 1021-A Standard-Signal Generator, the simple TYPE 1000-P6 Crystal Diode Modulator, described in the following article, is recommended. The output of this modulator is of the order of 10 millivolts. The actual percentage modulation, which is limited to about 50%, is not accurately known without measurement, but the modulation characteristic is flat within 2 db up to 5 Mc. It is possible, therefore, to produce television picture signals on all channels between 50 and 920 Mc. A convenient source of television video signals is a standard television receiver tuned to a local station.

## FEATURES

Probably the outstanding feature of the TYPE 1021-A Standard-Signal Generator is its convenience and reliability.

[7] D. B. Sinclair, "A Versatile Amplitude Modulator for V-H-F Signal Generators," *General Radio Experimenter*, November, 1949.

Figure 5. The Type 1021-AV V-H-F Standard-Signal Generator and the Type 1023-A Amplitude Modulator, arranged for tests on a communications-type receiver.



It brings to the V-H-F and U-H-F ranges the same ease of operation that is characteristic of most signal generators at lower frequencies, but which has not hitherto been available at frequencies as high as 920 Mc.

The carrier oscillators cover wide frequency ranges with smooth control, since no sliding contacts are used in the tuned circuits. The tuning element is driven by a worm gear. The driving shaft carries a 100 division dial which makes over eleven turns to cover the range. Frequency calibration extends over 270° on a 6″ dial. The oscillator units are enclosed in double shields, and all supply leads are well filtered. Residual output voltage and leakage are below the sensitivity of most receivers. The butterfly oscillators are of rugged design, which ensures good stability and low drift. Regulated supply voltage helps to produce clear beat tones when the output is heterodyned. The mutual inductance type attenuator has a smooth rack and pinion drive. The output terminals are fitted with the new TYPE 874 Universal Coaxial Connectors, which fit a wide variety of output accessories.

—EDUARD KARPLUS
ERVIN E. GROSS

## SPECIFICATIONS

### Type 1021-AU U-H-F Standard-Signal Generator

**Carrier Frequency Range:** 250 Mc to 920 Mc in one band.

**Frequency Calibration:** Direct reading to ±1%.

**Output Voltage:** Continuously adjustable from 0.5 μv to 1.0 volt, open-circuit.

**Output Impedance:** 50 ohms ±10%.

**Output Voltage Accuracy:** Over-all accuracy of output voltage is better than ±20%. The accuracy of output voltmeter calibration between 0.5 volt and 1.0 volt is better than ±10%. The accuracy of the attenuator dial calibration for voltages between 1.0 μv and 0.1 volt is better than ±5%; from 0.1 volt to 0.5 volt, better than ±10%. At 920 Mc, the reasonance error in the voltmeter is +6%.

**Amplitude Modulation:** Adjustable, 0 to 50%. Internal, 1000 c ±5%. External, flat within 3 db from 30 c to 15 kc. For 50% modulation, external audio oscillator must supply 12 volts across a 100 kilohm load.

**Envelope Distortion:** Approximately 5% at 50% modulation.

**Noise Level:** Carrier noise level corresponds to about 0.2% modulation.

**Incidental Frequency Modulation:** For 50% amplitude modulation the incidental fm is approximately 100 parts per million for frequencies up to 400 Mc and is approximately 1000 parts per million at 920 Mc. When lower values of incidental fm are required, the TYPE 1000-P6 Crystal Modulator is recommended.

**Leakage:** Stray fields and residual output voltage cannot be detected with a receiver having 2 to 3 μv sensitivity.

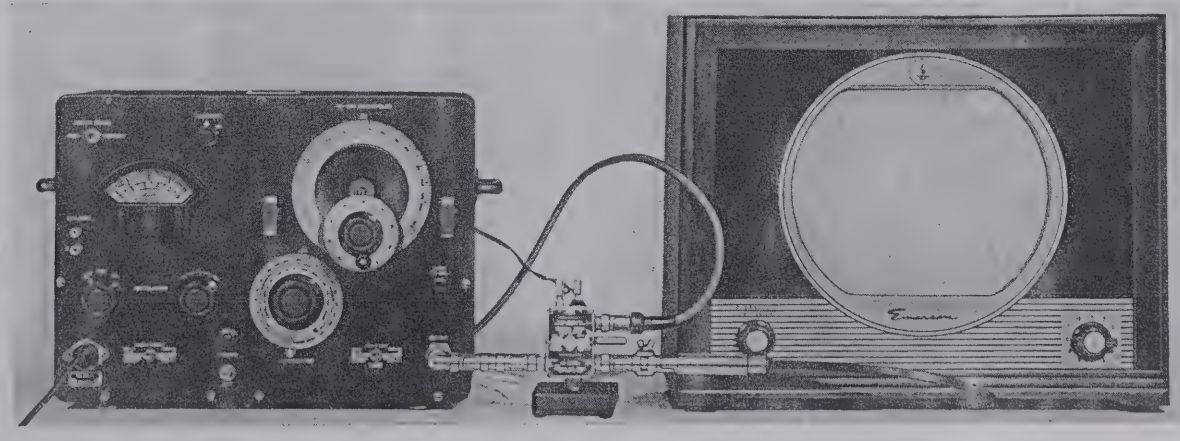
**Terminals:** TYPE 874 Coaxial Terminals are provided for the output connection.

**Power Supply:** 115 or 230 volts, 50 to 60 cycles. Power input is approximately 50 watts.

**Tubes:** Supplied with the instrument:

| | | | |
|---|---|---|---|
| 1 | Sylvania 5767 (Oscillator) | | |
| 1 | 6X5-GT | 1 | Amperite 6–4 |
| 1 | 6K6-GT | 2 | OC3/VR105 |

Figure 5. The Type 1021-AV V-H-F Standard-Signal Generator with Type 1000-P6 Crystal Diode Modulator, set up for tests on a television receiver.



**Accessories Supplied:**
1 TYPE 874-R20 3-foot Coaxial Cable (50 Ω)
1 TYPE 874-C Coaxial Cable Connector
1 TYPE CAP-35 Power Cord

**Other Accessories Available:** Not supplied, but available on order are TYPE 874-GF 20 db Attenuator Pad, TYPE 874-GG 10 db Attenuator Pad, TYPE 874-K Coupling Capacitor, and TYPE 1000-P6 Crystal Modulator.

**Mounting:** The aluminum cabinet has a black wrinkle finish. The left-hand side houses the TYPE 1021-P1 Power Supply; the right-hand side houses the TYPE 1021-P2 U-H-F Unit. Panels are black crackle-finished aluminum.

**Dimensions:** (Height) 14⅜ x (width) 20¼ x (depth) 10 9/16 inches, overall.

**Net Weight:** 34 pounds.

**Type 1021-AV V-H-F Standard-Signal Generator**

Same as TYPE 1021-AU (above) except as noted.

**Carrier Frequency Range:** 50 Mc to 250 Mc in one band.

**Incidental Frequency Modulation:** For 50% amplitude modulation the incidental fm is approximately 100 parts per million for frequencies up to 100 Mc, and is approximately 500 parts per million at 250 Mc. When lower values of incidental fm are required, the TYPE 1000-P6 Crystal Modulator or the TYPE 1023-A Amplitude Modulator is recommended.

**Tubes:** Supplied with the instrument:
1 GE 12AT7 (Oscillator)
Other tubes as listed above.

**Net Weight:** 36 pounds.

| *Type* | | *Code Word* | *Price* |
|---|---|---|---|
| 1021-AU | U-H-F Standard-Signal Generator, 250–920 Mc* . . | EVADE | $615.00 |
| 1021-AV | V-H-F Standard-Signal Generator, 50–250 Mc* . . . | EVENT | 595.00 |
| 1021-P2 | U-H-F Oscillator Unit only, 250–920 Mc* . . . . . | ETHIC | 420.00 |
| 1021-P3 | V-H-F Oscillator Unit only, 50–250 Mc* . . . . . | EVOKE | 400.00 |

*U. S. Patent No. 2,125,816; also Patent Applied For.

# AN AMPLITUDE MODULATOR FOR VIDEO FREQUENCIES

The TYPE 1000-P6 Crystal Diode Modulator is a small, convenient device for amplitude modulating the output of a radio-frequency source. With standard-signal generators it modulates the radio-frequency signal at normal attenuator output levels, and, because it is isolated from the oscillator by an attenuator, reaction on the oscillator frequency, or incidental fm, is usually completely negligible.

The crystal diode modulator is designed for wide-band modulation, 0 to 5 megacycles, at carrier frequencies between 20 and 1000 megacycles. Hence it is particularly useful in testing television receivers, whether in the laboratory, in production, or in the service shop. It converts a conventional standard-signal generator or oscillator to a useful test-signal generator for television receivers, and its range covers both the currently used bands and the proposed new u-h-f bands, as well as receiver intermediate frequencies.

This modulator is also useful with other types of receivers operating within its carrier-frequency range, for a-m tests where the incidental fm that is inherent in a directly modulated oscillator cannot be tolerated.

As shown in Figure 2, the TYPE 1000-P6 Crystal Diode Modulator consists of a crystal diode between input and output terminals, a simple output filter to

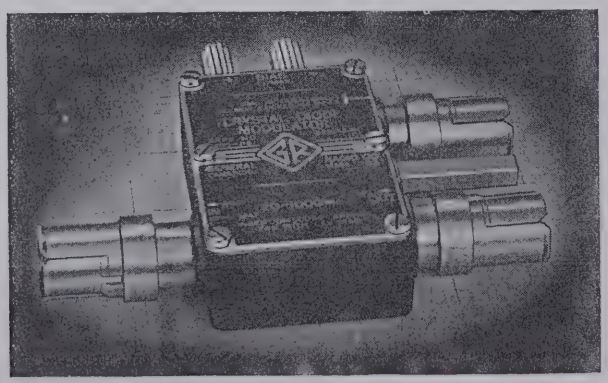
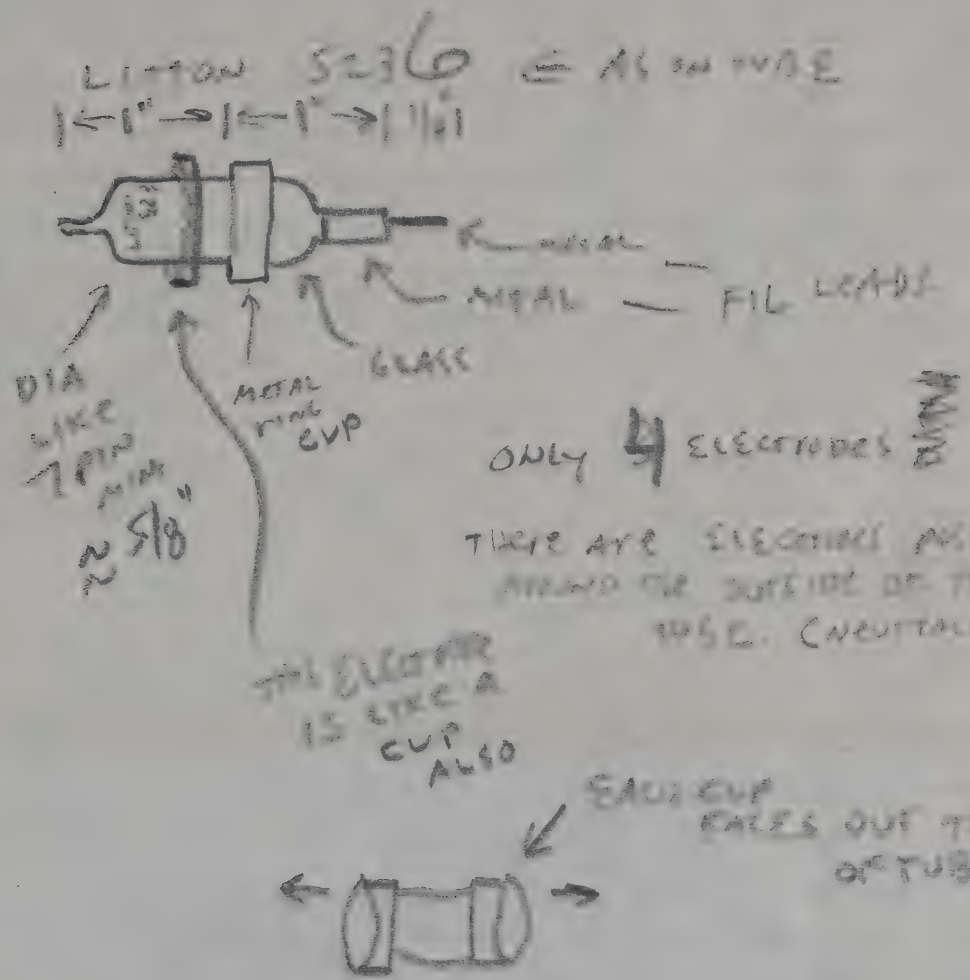


Figure 1. View of the Type 1000-P6 Crystal Diode Modulator.

OSCILLATOR IN 6 SW RADIO 102 I-A
S16 GEN

LITTON 5236 ← ALSO TUBE


1" 1" 1 1/8"
METAL
METAL — FIL LEADS
GLASS
DIA LIKE 7 PIN MIN
METAL RING EVP
ONLY 4 ELECTRODES USED
THERE ARE ELECTRODES POSITIONED AROUND THE OUTSIDE OF THE TUBE. (NEUTRALIZING?)
THIS ELECTRODE IS LIKE A CUP ALSO
EACH CUP FACES OUT TO END OF TUBE

FREQ 500 MAX SET

2:20 AM THURS OCT 7 1954

TUBES IN

PWR SUPPLY
6X6G
2x 0C3 VR105
6X5 GTG
AMPERITE 6-4 BALLAST

FREQ RANGE 2.46 MHz → 9.60 MHz

FREQ VERY STABLE AFTER WARMUP
SET 500 MHz DRIFT OVER 1 HR
AFTER WARMUP ± 12 KHz or so

VOLTAGE OUTPUT ON METER
SEEMS TO BE P-P VOLTS NOT RMS

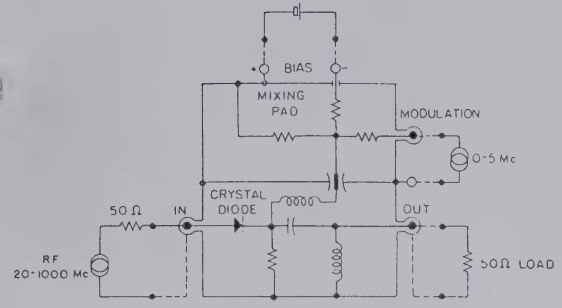



Figure 2. Circuit of the modulator.

prevent appreciable modulating voltage appearing in the output, and a means of isolating and applying modulating and bias voltages. Since the resistance of the crystal diode is a function of the voltage across it, this resistance can be modulated by applying a varying voltage. This unit, therefore, when inserted in series with a radio-frequency generator and its load, will produce amplitude modulation.

The modulator has been designed to operate between 50-ohm source and load impedances. The r-f source impedance must be low, not only at the carrier frequency but also at the modulating frequency and dc, in order that the modulation and bias will be properly applied to the crystal. The use of 50-ohm, 10- or 20-db, resistive pads[1] at the input and output of the modulator will make its characteristics relatively independent of the source and load impedance and, in addition, the combination will present an essentially constant impedance to the source and load. 20-db pads are preferable if the attenuation can be tolerated.

The maximum r-f input voltage should be limited to about 50 millivolts behind 50 ohms to avoid serious carrier and modulation distortion. Below this level, the percentage modulation is practically independent of the radio frequency applied so that any desired attenuation can be introduced ahead of the modulator.

For sine-wave modulation, bias can be applied by connecting a 1.5-volt battery to the bias terminals. This reduces the crystal resistance from the high unbiased condition to a value that is approximately in the center of the characteristic of an average crystal. Increasing the bias increases the output. If means are available for observing the modulation characteristic, some improvement may be had by adjusting the bias for optimum results. With an asymmetrical modulating signal, an adjustable bias supply is recommended if the maximum capabilities of the modulator are to be obtained. Since dc can also be applied through the modulation terminals, the bias may be included as part of the modulating voltage. If no bias at all is applied, the modulator will function on the negative cycles of the modulating voltage to produce a chopped output. Of course, no bias is necessary if the applied modulation consists only of negative pulses.

A suitable source of television video signals for test purposes is a standard television receiver tuned to a local television station. The output can be taken from the plate circuit of the last video amplifier by means of a large coupling capacitor and a suitably compensated voltage divider. The polarity of the video signal obtained at this point is

[1]Such as General Radio Type 874-GF Fixed Attenuator (20 db) or Type 874-GG Fixed Attenuator (10 db).

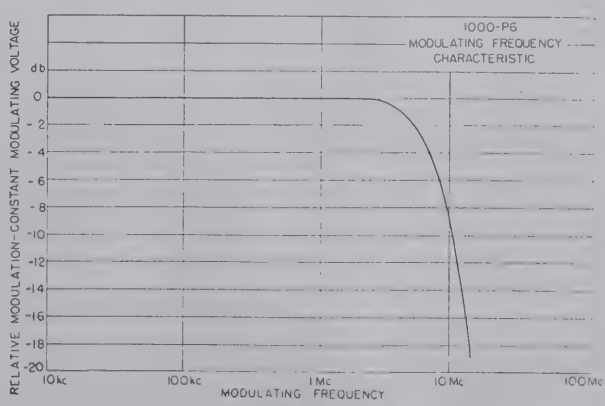



Figure 3. Modulating frequency characteristic.

correct for applying to the modulator, and a large voltage division is possible, permitting a minimum disturbance of the receiver circuit conditions. The exact modulating and bias voltages required are best determined experimentally. A 60:1 voltage divider at the output of the television receiver supplying the video signal has been found to give satisfactory results. The TYPE 1000-P5 Transformer is available for coupling the modulator to a television receiver input.

The TYPE 1N21-B crystal can be easily replaced by taking off the input connector. The connector is held in place with a threaded ring.

—W. F. BYERS

## SPECIFICATIONS

**Carrier Frequency Range:** 20 to 1000 megacycles. The insertion loss increases approximately 10 db at a carrier frequency of 10 megacycles due to output filter.

**Modulating Frequency Range:** 0 to 5 megacycles. Response is approximately 2 db down at 5 megacycles with a gradual roll-off to prevent serious phase distortion of video signals.

**Impedance:** The impedance looking into either the input or output terminals is a function of the bias and modulating voltages. This unit was designed for use with a 50-ohm source and a 50-ohm load. The impedance at the modulation terminals is approximately 600 ohms.

**Modulation:** With no greater than 50 millivolts r-f input, 30% amplitude modulation can be obtained at carrier frequencies between 20 and 1000 Mc. For optimum sine-wave modulation, an average crystal requires 1.5 volts at the bias terminal. The insertion loss under these conditions is approximately 12 db, and approximately 0.2 volt r-m-s at the modulation terminals will produce 30% modulation. Maximum percentage modulation is an inverse function of carrier frequency, and at 1000 megacycles is limited to about 30%. Peak modulation voltage with respect to ground should not exceed 4 volts.

**Terminals:** The radio-frequency and modulating terminals are provided with TYPE 874 Coaxial Connectors. The modulation terminals will accept either a TYPE 874 Coaxial Connector or a TYPE 274-M Plug.

**Crystal Diode:** 1N21B.

**Accessories Supplied:** One TYPE 274-M Plug.

**Other Accessories Required:** Terminal adaptors, unless generator and load are equipped with TYPE 874 Coaxial Connectors; 1.5-volt battery for fixed bias, or a 3-volt battery and a 10,000-ohm rheostat for adjustable bias.

**Accessories Available:**

TYPE 874-GF Fixed Attenuator, 20 db
TYPE 874-GG Fixed Attenuator, 10 db
TYPE 874-R20 Patch Cord
TYPE 1000-P5 V-H-F Transformer
(For descriptions and prices, see *Experimenter*, Nov. '49 and Jan. '50.)

**Dimensions:** (Width) 5 x (height) 4 x (depth) $1\frac{1}{16}$ inches, overall.

**Net Weight:** 1 pound.

| *Type* | | *Code Word* | *Price* |
|---|---|---|---|
| 1000-P6 | Crystal Diode Modulator* . . . . . | APPLE | $35.00 |

*U. S. Patent No. 2,125,816; also Patent Applied For.

GENERAL RADIO COMPANY
275 MASSACHUSETTS AVENUE
CAMBRIDGE 39 MASSACHUSETTS
TELEPHONE: TRowbridge 6-4400

BRANCH ENGINEERING OFFICES

NEW YORK 6, NEW YORK
90 WEST STREET
TEL.—WOrth 2-5837

LOS ANGELES 38, CALIFORNIA
1000 NORTH SEWARD STREET
TEL.—HOllywood 9-6201

CHICAGO 5, ILLINOIS
920 SOUTH MICHIGAN AVENUE
TEL.—WAbash 2-3820

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